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Rio Blanco Oil Shale Project

PROGRESS REPORT 1

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and
Standard Oil Company (Indiana)
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PROGRESS REPORT NUMBER 1

on

TRACT C-a OIL SHALE DEVELOPMENT

to

AREA OIL SHALE SUPERVISOR
UNITED STATES GEOLOGICAL SURVEY

by

RIO BLANCO OIL SHALE PROJECT
of
GULF OIL CORPORATION
and
STANDARD OIL COMPANY (INDIANA)

TABLE OF CONTENTS

Foreword 1

Summary 2

Problem Areas 20

Activity Planned 21

Schedules and Status 23

Appendix
- Preliminary Printouts From Water Quality Stations
- Corehole Completion Reports
- Support Roads and Facilities Location Plan

Figure 1 - Coring Operation, Tract C-a 4

Figure 2 - Aerial Photograph of Tract C-a 8

Figure 3 - Drilling on Tract C-a 10

Figure 4 - Technician Prepares to Launch Pilot Balloon to Measure Wind Speed and Direction to Altitude of 3,000 Feet Above Tract C-a 14

Figure 5 - Cataloging and Physical Characteristic Identification of Small Mammals 16

Figure 6 - Water Sampling Near Tract C-a 18

FOREWORD

This is the first of a series of quarterly reports to be submitted to the Area Oil Shale Supervisor of the U.S. Geological Survey. The period covered by this report is from the date of the lease to Tract C-a to September 30, 1974. The next report will span the five months through February 28, 1975. Thereafter, reports will be at three month intervals, each covering a seasonal quarter of the year.

Only a limited amount of environmental baseline and monitoring data was collected during this period of organization and geotechnical data gathering. In future reports these subjects will be covered in much more depth.

SUMMARY

A. GENERAL

The period covered in this report has been one of intensive organizational efforts by people of the Rio Blanco Oil Shale Project. With the formation of a team of qualified management, engineering and scientific personnel, work has been proceeding to identify, assign and integrate specific tasks aimed at preparation of the Detailed Development Plan. In addition to development of intra-organizational policies and procedures, the period has been a time for establishing working relationships with various agencies which administer or have some degree of responsibility for various aspects of oil shale development.

In May of 1974, the required Exploratory Plan was submitted and approved with additional stipulations. Many of the tasks set forth in that plan are underway. Environmental baseline data collection programs were launched during this period. Also, collection of additional geological and hydrological resource data was undertaken and is nearing completion.

To insure protection of potential unique areas of archaeological value as well as indigenous plant and animal communities, lease stipulations require archaeological and biological clearance prior to drilling activities and access road construction. Dr. Alan Olson, University of Denver Archaeologist, and David Winsor, Limnetics, Inc. Terrestial Ecologist, were selected to perform clearance work. The clearing of the areas was initiated during late June and was completed about September 15.

The effort to select a general mining and processing engineering contractor was started in September. A Process Task Force to prepare a plan for initial operations completed its work during the period and negotiations were opened with other private interests to acquire technology adjudged useful for the project.

A water acquisition program was begun during the period. In addition, negotiations were opened with the State of Colorado and private surface owners in the area of Tract C-a for land acquisitions and exchanges which may be mutually desirable.

Figure 1

Coring Operation - Tract C-a

B. GEOLOGY

1. Corehole Program

Ten of thirteen coreholes were completed as of October 2, 1974. Information relative to core recovery is shown in the following tabulation.

CORE RECOVERY DATA

CH No.	TD	Core Cut	Core Rec.	Core Lost	% Rec.
1	1404	1360.7	1317.1	43.6	96.8
2-3	1424	1352.5	1240.0	112.5	91.7
4-5	1663	1615.5	1486.2	129.3	92.0
6	1781	1624.5	1565.0	59.5	96.3
7	1200	1159.7	1148.2	11.5	98.9
8	1616	1548.2	1458.6	89.6	94.2
9	1600	1556.4	1357.5	198.9	87.2*
10	1902	1549.6	1454.8	94.8	93.9
12	1800	1759.0	1588.6	170.4	90.3*
13	1751	1481.0	1387.2	93.8	93.7
Totals:	16,141'	15,007.1'	14,003.2'	1003.9'	(93.3 Avg.)

*Coreholes located in fault zones; lower recovery due to fractured shale.

Amuedo and Ivey, geologic contractor, is logging and boxing core on sites. A & I is also selecting intervals containing nahcolite for analysis by Core Lab. Final geologic reports for each corehole will be prepared including lithologic and RQD (rock quality designation) logs. Preliminary logs are completed on CH Nos. 1, 2-3, 4-5, 6, 7 and 8.

Schlumberger, the original geophysical logging contractor, has been replaced by Birdwell Division of Seismograph Service Corporation. The following table lists the logs run in each completed corehole.

RIO BLANCO OIL SHALE PROJECT

COREHOLE NUMBER	GEOPHYSICAL LOGS												
	CH 1	CH 2-3	CH 4-5	CH 6	CH 7	CH 8	CH 9	CH 10	CH 11	CH 12	CH 13	CH 14	CH 15
SCHLUMBERGER													
Dual Ind. Laterolog	x	x		x	x	x							
Comp. Neutron Formation Density	x	x		x	x	x							
Borehole Comp. Sonic-Gamma Ray		x		x	x	x							
Engineered Production (Spinner-Temp)				x		x							
Continuous Directional						x							
BIRDWELL													
Electric			x				x			x	x		
Gamma Ray Density-Neutron							x			x			
3-Dimensional Velocity	x		x				x			x	x		
Temperature	x	x	x				x			x	x		
Spinner	x	x	x				x			x	x		
Caliper (only)	x		x										
Seisviewer		x			x		x			x			
Nuclear = GR - Neutron			x								x		
Density			x										
Gamma Ray-Density											x		

McDowell-Smith and Associates of Rifle is the surveying contractor for all drill-sites as well as environmental monitoring stations. All corehole locations have been surveyed except Nos. 14 and 15.

Fischer assaying of oil shale core is proceeding at Core Lab's facilities in Rifle. CH No. 7 is completed, CH No. 2-3 is in progress. Oil samples generated from the assays are being stored for future use. Core and overburden intervals are being selected in eight coreholes spaced across the Tract for trace elements (in both fresh and assayed samples) and extractable alumina (in assayed samples only).

Selection completed: CH Nos. 1, 2-3, 4-5, and 7
Selection fothcoming: CH Nos. 9, 10, 11 and 15.
Oil shale intervals in CH Nos. 1, 6 and 15 are being considered for bulk density determinations to accurately define G/T-G/cu. ft. relationships representative of the Tract.

2. Aerial Photography

Limbaugh Engineers, Inc., through its sub-contractor, IntraSearch, have completed all aerial photography over approximately 390 square miles. Coverage received to date:

100% of 1" - 3000' color prints.
70% of 1" - 1000' color prints.
35% of 1" - 1000' color-infrared prints.

Construction of photo indices is in progress.

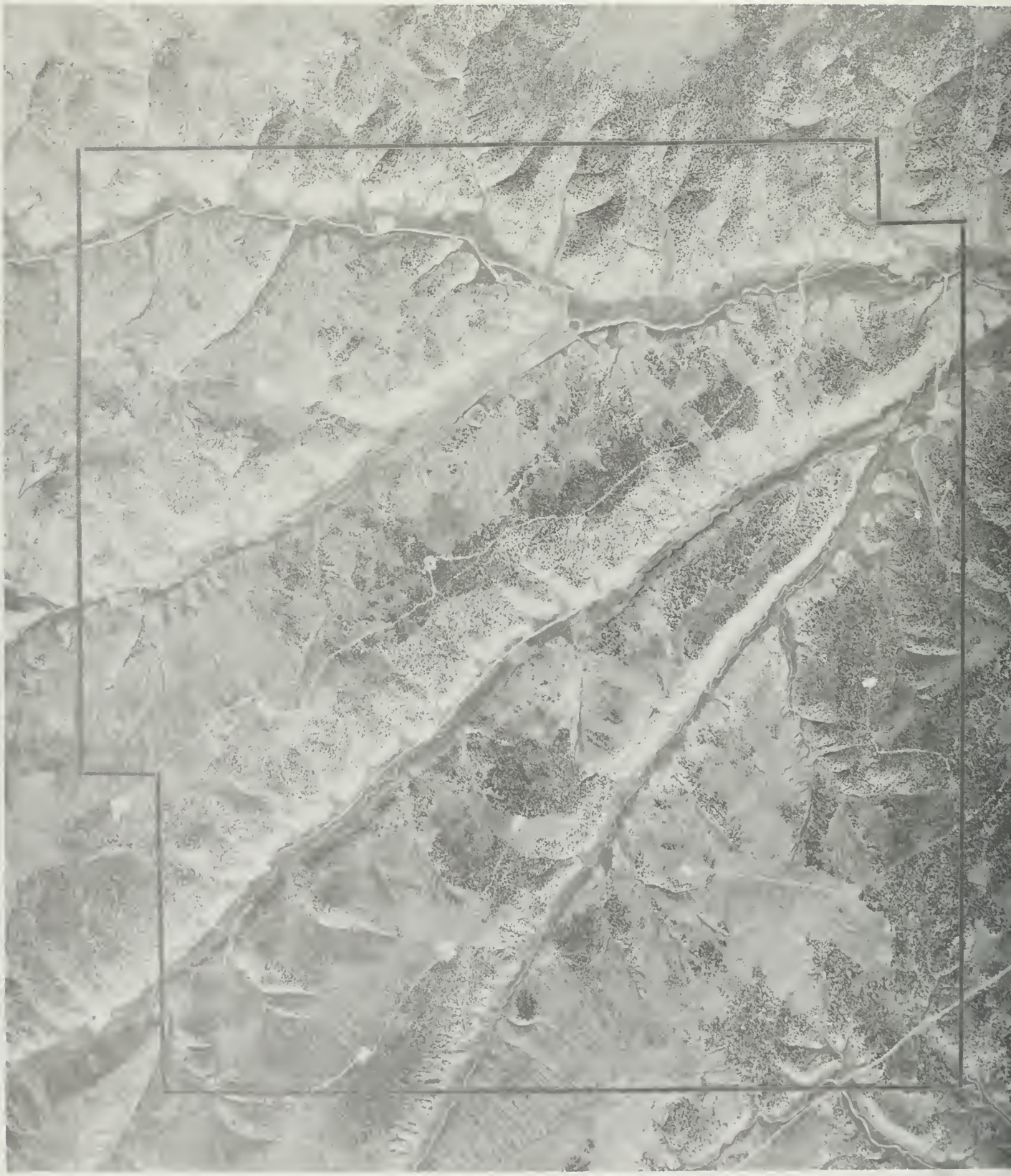


Figure 2

Aerial Photograph of Tract C-a

3. Photogeology - Surface Geologic Mapping

Trollinger and Associates have commenced photogeologic mapping and interpretation of an 81 square mile area in and around Tract C-a. Completion of the preliminary map is scheduled for October 15. This map will provide the basis for forthcoming surface geologic mapping by Amuedo & Ivey.

4. Topographic Mapping

Limbaugh Engineers, Inc. have completed about 30% of the detailed topographic mapping (1'-200' horizontal scale, 5' contour interval) covering Tract C-a and vicinity and two dam sites. Total area to be mapped covers approximately 85 square miles.

5. Seismic:

Cameron Engineers has prepared a Request For Proposal (RFP) for approximately 10 miles of shallow high resolution seismic lines across Tract C-a. The prime objectives of this seismic program are to further define the known surface faulting and locate possible additional faulting not exposed at the surface. RFP's were sent to several potential contractors on September 28, 1974.

Figure 3

Drilling on Tract C-a

C. HYDROLOGY

1. Subsurface

Wright Water Engineers have prepared a completion report on eight of the ten completed coreholes. These include CH 1, CH 2-3, CH 4-5, CH 6, CH 7, CH 8, CH 9, and CH 12. A summary of the data contained in the completion reports is shown on the following table.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: at first significant production, end of the "B groove" pump test, increase in production after "B groove," and at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling. After the "B groove" was penetrated, the water level recovery was measured with the use of wire-line pressure recorder. Upon reaching total depth, a similar test was run with the recovery data collected by a downhole pressure recorder set inside the drillstring.

RIO BLANCO OIL SHALE PROJECT

COREHOLE HYDROLOGIC COMPLETION SUMMARY

HOLE NUMBER	CH 1	CH 2-3	CH 4-5	CH 6	CH 7	CH 8	CH 9	CH 12
AQUIFER INTERVALS								
Upper	420-450	235-475	202-650	180-630	200-380	460-720	300-630	540-890
Lower	910-1404	900-1424	1180-1663	1300-1780	690-1200	1150-1600	1080-1600	1280-1800
UPPER AQUIFER DATA								
Static Water Level	248	120	40	40	10	345	320	450
Production GPM	65	180	360	300	35	90	100	60
Transmissivity GPD/Ft.	I.D.	3000	6800	175-19,800	40-770	I.D.	I.D.	110-7900
Specific Capacity GPM/Ft.	.43	1.7	3.6	.50	.46	I.D.	.5	.34
Avg. Spec. Cond. μ mhos/cm.	1000	1160	1210	1200	1000	1100	1520	1700
Avg. Temperature °F	57	59	60	62	57	59	58	59
Avg. pH	6.7	7.0	6.7	7.6	7.1	7.0	6.7	7.0
COMBINED AQUIFER DATA								
Static Water Level	270	180	65	200	390	520	370	580
Production GPM	170	490	850	530	240	210	300	275
Transmissivity GPD/Ft.	150-170	550-1800	11,800	365	320-1670	400-1200	240-1200	680-7300
Special Capacity GPM/Ft.	.18	.85	6.4	.24	1.1	.84	.63	1.5
Avg. Spec. Cond. μ mhos/cm.	2055	2760	2850	2840	1300	2250	2600	2860
Avg. Temperature °F	59	71	76	75	62	64	69	70
Avg. pH	6.8	7.4	7.5	7.9	6.9	7.5	7.4	7.7
HOLE DATA								
Date Started	Aug. 10	July 27	Aug. 10	July 3	July 26	June 28	Aug. 28	Sep. 3
Date Completed	Aug. 24	Aug. 10	Sep. 1	July 23	Aug. 7	July 19	Sep. 12	Sep. 15
Total Depth	1404	1424	1663	1781	1200	1616	1600	1300

Note: I.D. = Insufficient Data

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during dirlling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well.

2. Surface

Surface water gauging and quality monitoring stations were established on major drainages around the tract by the USGS under a program sponsored by the Colorado River Water Conservation District and supported by Rio Blanco. Preliminary printouts from water quality stations are enclosed.

Figure 4

Technician Prepares to Launch Pilot Balloon to Measure Wind Speed and Direction to Altitude of 3000 Feet Above Tract C-a

D. AIR QUALITY AND METEOROLOGICAL

The RFP to perform the air quality and meteorological studies was submitted to six contractors on May 8, 1974. Five proposals were evaluated from May 20 through June 1 and the award to perform these studies was made to EG&G, Environmental Consultants, located in Albuquerque, New Mexico.

On approximately June 15, the scope-of-work of the EG&G study, was submitted to the Oil Shale Supervisor for approval. The approval, with accompanying conditions was signed by the Supervisor's office on July 14. The 10 conditions made by the Supervisor have been studied and 9 of the 10 conditions were negotiated with EG&G on September 4. Of the stipulations provided to this office by the Mining Supervisor, the only one that remains to be resolved is visibility measurements. Presently, three techniques are being evaluated by Limnetics and once a firm decision has been made, this procedure will be submitted to the Supervisor for his approval.

Presently, all the instrumentation, trailors, fencing and towers have been installed and are in place on Tract C-a. All four sites should become operational by October 14.

Figure 5

Cataloging and Physical Characteristic
Identification of Small Mammals

E. TERRESTRIAL BASELINE DATA

The RFP for the Terrestrial Baseline Data Monitoring Program was submitted to 12 contractors on July 26. Ten proposals were received and evaluated between August 26 and August 31. The contract award was made to Ecology Consultants, Inc. (ECI), Ft. Collins, Colorado, on September 10. ECI, as a result of comments received from various State and Federal agencies, has revised their proposal and has submitted a new scope-of-work, to Limnetics, on October 4. This document, in turn, was forwarded to the Oil Shale Supervisor's office for their approval on that same date.

During September, ECI reviewed Tract C-a and the surrounding areas and selected three exclosures, each three acres in size, to determine animal grazing habits. A SLUP is presently being prepared for the construction of two of these exclosures in off tract areas.

Figure 6

Water Sampling near Tract C-a

F. AQUATIC BASELINE DATA

The RFP for the Aquatic Baseline Data Accumulation Program was submitted to 12 contractors on July 30.

Ten proposals were evaluated during the period from August 26 to August 31. The aquatic study was awarded to NUS, Pittsburgh, Pennsylvania, on September 10. As a result of various comments received from State and Federal agencies, NUS was requested to submit a new scope-of-work incorporating these comments. This scope-of-work was received on October 4 and was submitted to the Oil Shale Supervisor's office on the same day.

PROBLEM AREAS

Some delays were experienced in obtaining fencing and tower materials for the meteorological and air quality stations. Also problems were encountered in obtaining electrical power and a communication system to service these stations.

Another significant problem was encountered in contracting for a third drilling rig and this effort had to be abandoned. Because of this, the drilling program was slowed and approval was sought and received from the Area Oil Shale Supervisor for reduction of overburden coring in CH's. 10, 11, 13 and 14.

ACTIVITY PLANNED

Limnetics, Inc., Environmental Coordinator, is presently preparing RFP's for a full archaeological survey of the Tract and the adjoining areas which may be disturbed due to spent shale disposal and plant construction. Another RFP will be prepared for a complete soil survey and mapping of on and off Tract sites. The last major RFP will cover revegetaion studies. Presently, this RFP may be broken down into several different studies which will cover various aspects of reclaiming and revegetating spent shale, disposal areas and other disturbed areas caused by the open mine process.

Limnetics major functions in the near future will be to provide assistance to the aquatic and terrestrial contractors in the managing of collected samples and data. One of these functions will be a quasi type of quality control function which will insure the collection of data to prescribed methods, techniques and analysis. To fulfill requirements of the final report, Limnetics will initiate a statistical plan which can be used in the future to show the inter-relationship of the various eco-systems that are now under study.

One service rig is currently working on the plugging and abandoning of two previously-drilled coreholes. After finishing this work the rig will begin completing old coreholes for the purposes of pump testing and monitoring. A second service rig will be utilized to expedite completion of the hydrology monitoring holes.

In order to obtain accurate aquifer characteristics, we intend to drill four deep, large diameter lower aquifer pump test holes. It should be noted, however, that the drilling of these holes is contingent upon the results of the 24-hour pump tests to be conducted in existing core-holes (and upon EPA approval of point discharge permits allowing water of a maximum conductivity of 5,000 micromhos/centimeter at 25°C. to be discharged to the surface drainage).

A revised contract with the Colorado River Water Conservancy District is currently being negotiated. This revised contract will include analysis for the chemical constituents required by the Area Oil Shale Supervisor and will also include storage rain gages on Box Elder Gulch, Corral Gulch, and Dry Fork located at the surface gaging stations on the western edge of the tract. In addition, recording rain gages will be located on Stakes Springs Draw at the mouth of Yellow Creek and on Cathedral Bluffs.

Pending approval of the Area Oil Shale Supervisor, a seventh surface station would be located on "Rinky Dink Gulch" just above the confluence with Box Elder Gulch. This station would be similar in construction to the other six stations.

A contract will be let in November for major planning and preliminary design studies for the development of the mining, processing and supporting facilities.

SCHEDULES AND STATUS

Data submitted to the Area Oil Shale Supervisor as of September 30, 1974 is summarized on the following table.

An outline of the Detailed Development Plan has been developed. This will be completed, refined and submitted as part of the next quarterly report.

DATA TRANSMITTED TO AREA OIL SHALE SUPERVISOR
to September 30, 1974

	COREHOLES													Other Holes
	1	2-3	4-5	6	7	8	9	10	11	12	13	14	15	16
Geophysical Logs														
Schlumberger														
Dual Induction Laterlog	x	x		x	x	x								
Formation Density	x			x	x	x								
Sonic Gamma		x		x	x	x								
Engineered Production				x		x								
Continuous Directional						x								
Birdwell														
Electric			x				x			x				
Density	x		x				x			x				
3-Dimensional Vel.	x		x				x			x				
Temperature	x	x	x				x			x				
Spinner	x	x	x				x			x				
Caliper	x		x											
Seisviewer		x			x									
Neutron			x				x			x				
Rock Structure Logs	x	x	x	x	x	x								
Fischer Assays					x									
Survey Plats-Elevations	x	x	x	x	x	x	x	x	x	x	x			x
Daily Water Quality and Estimated Quantity	x	x	x	x	x	x	x			x				

APPENDIX

United States Department of the Interior
GEOLOGICAL SURVEY
Denver Federal Center
Denver, Colorado 80225

Water Resources Division
Colorado District

IN REPLY REFER TO

September 4, 1974

Mr. Fred V. Witaschek
Gulf Mineral Resources Co.
Gulf Building
1780 S. Bellaire Street
Denver, Colorado 80222

Dear Mr. Witaschek:

Enclosed are preliminary printouts from the water-quality stations on tract C-a in the Piceance Creek basin on which analyses were completed by September 3, 1974.

These analyses are sent to you as part of the cooperative agreement with the Colorado River Water Conservation District.

FOR THE DISTRICT CHIEF

Sincerely yours,

John C. Briggs
Chemist

Enclosures

C-a

PROCESS DATE 09/03

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	TIME	TYPE	SAMPLE NUMBER (00008)	TEMPERATURE (DEG C) (00010)	DISCHARGE (CFS) (00060)	INSTANTANEOUS DISCHARGE (CFS) (00061)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKALINITY AS CACO3 (MG/L) (00410)	BICARBONATE (HCO3) (MG/L) (00440)	CARBONATE (CO3) (MG/L) (00445)
MAR.												
14...	1130	2	--	4.5	.31	--	1060	7.9	7.6	311	379	0
25...	1300	2	--	9.0	.06	--	1100	7.8	10	326	398	0
APR.												
04...	1030	2	--	.5	--	.33	1110	8.1	5.4	350	427	0
19...	1050	2	--	8.0	--	.17	1100	7.9	7.8	317	386	0
27...	1000	2	--	7.5	--	1.1	1140	7.9	9.1	372	454	0
MAY												
03...	1215	2	--	18.0	--	.49	1090	8.0	6.6	338	412	0
17...	1050	2	1878	10.5	--	.79	1080	7.9	8.3	337	411	0
30...	1255	2	--	22.5	--	.37	1050	7.9	7.2	291	355	0

PROCESS DATE 09/03/74

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)	DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) (00660)	DIS-SOLVED ORTHO, PHOS-PHORUS (P) (MG/L) (00671)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD-SORP-TION RATIO (00931)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L) (00935)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)
MAR.												
14...	1.1	.09	.03	440	130	85	55	84	1.7	29	1.3	7.4
25...	2.2	.09	.03	460	140	92	57	85	1.7	28	1.4	8.2
APR.												
04...	1.2	.09	.03	470	120	92	58	88	1.8	29	1.4	7.1
19...	1.0	.03	.01	470	160	90	60	88	1.8	29	1.2	8.0
27...	.95	.15	.05	460	88	87	59	88	1.8	29	1.8	7.5
MAY												
03...	1.8	.06	.02	460	120	90	56	78	1.6	27	1.7	6.7
17...	1.9	.00	.00	480	140	97	57	74	1.5	25	1.2	5.7
30...	1.6	.06	.02	450	160	82	60	78	1.6	27	1.3	6.0

PROCESS DATE 09/03/74

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BARIUM (BA) (UG/L) (01005)	DIS-SOLVED BERYL-LIUM (BE) (UG/L) (01010)	DIS-SOLVED BISMUTH (BI) (UG/L) (01015)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CAD-MIUM (CD) (UG/L) (01025)	DIS-SOLVED CHRO-MIUM (CR) (UG/L) (01030)	DIS-SOLVED COBALT (CO) (UG/L) (01035)	DIS-SOLVED COPPER (CU) (UG/L) (01040)
MAR.												
14...	280	.3	20	--	--	--	--	--	--	--	--	--
25...	280	.6	19	--	--	--	--	--	--	--	--	--
APR.												
04...	260	.8	19	1	--	--	--	--	1	--	--	--
19...	320	.3	22	23	--	--	--	--	3	--	--	--
27...	270	.9	24	--	--	--	--	--	--	--	--	--
MAY												
03...	260	1.5	24	--	--	--	--	--	--	--	--	--
17...	260	.7	23	9	120	<5	<10	80	2	<7	<14	5
30...	270	.3	24	4	200	--	--	110	1	--	--	4

PROCESS DATE 09/03/74

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED IRON (FE) (UG/L) (01046)	DIS-SOLVED LEAD (PB) (UG/L) (01049)	DIS-SOLVED MANGANESE (MN) (UG/L) (01056)	DIS-SOLVED MOLYBDENUM (MO) (UG/L) (01060)	DIS-SOLVED NICKEL (NI) (UG/L) (01065)	DIS-SOLVED SILVER (AG) (UG/L) (01075)	DIS-SOLVED STRONTIUM (SR) (UG/L) (01080)	DIS-SOLVED VANADIUM (V) (UG/L) (01085)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)	DIS-SOLVED TIN (SN) (UG/L) (01100)	DIS-SOLVED ALUMINUM (AL) (UG/L) (01106)
MAR.											
14...	20	--	0	--	--	--	--	--	--	--	--
25...	0	--	0	--	--	--	--	--	--	--	--
APR.											
04...	20	--	--	--	--	--	--	--	--	--	--
19...	80	--	0	--	--	--	--	--	--	--	--
27...	250	--	40	--	--	--	--	--	--	--	--
MAY											
03...	60	--	20	--	--	--	--	--	--	--	--
17...	140	<14	10	40	<7	<2	1500	<10	340	<10	220
30...	10	2	0	--	--	--	--	--	20	--	--

PROCESS DATE 09/03/74

09306235 - CORRAL GULCH BELOW WATER GULCH, NR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED GALLIUM (GA) (UG/L) (01120)	DIS-SOLVED GER-MANIUM (GE) (UG/L) (01125)	DIS-SOLVED LITHIUM (LI) (UG/L) (01130)	DIS-SOLVED SELE-NIUM (SE) (UG/L) (01145)	DIS-SOLVED TI-TANIUM (TI) (UG/L) (01150)	DIS-SOLVED ZIR-CONIUM (ZR) (UG/L) (01160)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	DIS-SOLVED SOLIDS (TONS PER AC-FT) (70303)	DIS-SOLVED MERCURY (HG) (UG/L) (71890)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE MSL) (72000)
MAR.											
14...	--	--	--	--	--	--	725	.61	.99	--	6980
25...	--	--	--	--	--	--	749	.12	1.02	--	6980
APR.											
04...	--	--	--	--	--	--	742	.66	1.01	.0	6980
19...	--	--	--	4	--	--	784	.36	1.07	--	6980
27...	--	--	--	--	--	--	767	2.42	1.04	--	6980
MAY											
03...	--	--	--	--	--	--	729	.96	.99	--	6980
17...	<7	<14	14	7	9	<20	730	1.56	.99	--	6980
30...	--	--	20	8	--	--	704	.70	.96	.0	6980

PROCESS DATE 09/03/74

09306240 - [illegible] ELDER GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	TIME	TYPE	SAMPLE NUMBER (00000A)	TEMPERATURE (DEG C) (00010)	INSTANTANEOUS DISCHARGE (CFS) (00061)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKALINITY AS CACO3 (MG/L) (00410)	BICARBONATE (HCO3) (MG/L) (00440)	CARBONATE (CO3) (MG/L) (00445)	DISSOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)
APR.												
27...	1135	2	--	10.0	2.5	898	7.9	7.8	317	386	0	1.5
MAY												
03...	1300	2	--	18.0	2.3	865	8.1	4.7	305	372	0	1.4
17...	1215	2	1879	12.5	2.4	822	8.0	5.7	291	355	0	1.4
24...	1230	2	--	16.0	1.3	1160	7.9	9.1	372	453	0	.75
30...	1420	2	--	25.0	.69	772	8.2	5.1	253	309	0	1.0

PROCESS DATE 09/03/74

09306240 - BOX ELDER GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) (00660)	DIS-SOLVED ORTHO. PHOS-PHORUS (P) (MG/L) (00671)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD-SORP-TION RATIO (00931)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L) (00935)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)
APR.												
27...	.06	.02	410	96	86	48	52	1.1	21	1.1	5.2	170
MAY												
03...	.00	.00	380	79	73	49	66	1.5	27	1.1	6.4	170
17...	.06	.02	380	84	76	45	48	1.1	22	.7	5.2	150
24...	.09	.03	460	87	83	61	93	1.9	31	1.4	8.2	280
30...	.06	.02	330	77	58	45	53	1.3	26	1.0	5.5	160

PROCESS DATE 09/03/74

09306240 - BOX ELDER GULCH NEAR RANGELY, CO.

DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BARIUM (BA) (UG/L) (01005)	DIS-SOLVED BERYL-LIUM (BE) (UG/L) (01010)	DIS-SOLVED BISMUTH (BI) (UG/L) (01015)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CAD-MIUM (CD) (UG/L) (01025)	DIS-SOLVED CHRO-MIUM (CR) (UG/L) (01030)	DIS-SOLVED COBALT (CO) (UG/L) (01035)	DIS-SOLVED COPPER (CU) (UG/L) (01040)
APR.											
27...	.7	23	--	--	--	--	--	--	--	--	--
MAY											
03...	.3	24	--	--	--	--	--	--	--	--	--
17...	.5	23	15	93	<4	<8	70	1	<5	<10	3
24...	.4	23	3	0	--	--	110	1	--	--	22
30...	.4	24	7	200	--	--	80	?	--	--	7

PROCESS DATE 09/03/74

09306240 - BOX ELDER GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED IRON (FE) (UG/L) (01046)	DIS-SOLVED LEAD (PB) (UG/L) (01049)	DIS-SOLVED MAN-GANESE (MN) (UG/L) (01056)	DIS-SOLVED MOLYB-DENUM (MO) (UG/L) (01060)	DIS-SOLVED NICKEL (NI) (UG/L) (01065)	DIS-SOLVED SILVER (AG) (UG/L) (01075)	DIS-SOLVED STRON-TIUM (SR) (UG/L) (01080)	DIS-SOLVED VANA-DIUM (V) (UG/L) (01085)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)	DIS-SOLVED TIN (SN) (UG/L) (01100)	DIS-SOLVED ALUM-INUM (AL) (UG/L) (01106)
APR.											
27...	500	--	20	--	--	--	--	--	--	--	--
MAY											
03...	120	--	0	--	--	--	--	--	--	--	--
17...	30	<10	0	35	<5	<1	1000	<5.0	65	<8	70
24...	20	1	0	--	--	--	--	--	10	--	--
30...	10	11	0	--	--	--	--	--	20	--	--

PROCESS DATE 09/03/74

09306240 - BOX ELDER GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED GALLIUM (GA) (UG/L) (01120)	DIS-SOLVED GER-MANIUM (GE) (UG/L) (01125)	DIS-SOLVED LITHIUM (LI) (UG/L) (01130)	DIS-SOLVED SELE-NIUM (SE) (UG/L) (01145)	DIS-SOLVED TI-TANIUM (TI) (UG/L) (01150)	DIS-SOLVED ZIR-CONIUM (ZR) (UG/L) (01160)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	DIS-SOLVED SOLIDS (TONS PER AC-FT) (70303)	DIS-SOLVED MERCURY (HG) (UG/L) (71890)	ELEV. OF LAND SURFACE DATUM (FT, ABOVE MSL) (72000)
APR.											
27...	--	--	--	--	--	--	584	4,08	,79	--	6955
MAY											
03...	--	--	--	--	--	--	580	3,62	,79	--	6955
17...	<5	<10	10	6	<5	<16	530	3,52	,72	--	6955
24...	--	--	20	4	--	--	777	2,83	1,06	,0	6955
30...	--	--	10	4	--	--	504	,94	,69	,2	6955

PROCESS DATE 09/03/74

09306242 - CORRAL GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	TIME	TYPE	SAMPLE NUMBER (00008)	TEMPERATURE (DEG C) (00010)	DISCHARGE (CFS) (00060)	INSTANTANEOUS DISCHARGE (CFS) (00061)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	PH (UNITS) (00400)	CARBON DIOXIDE (CO2) (MG/L) (00405)	ALKALINITY AS CACO3 (MG/L) (00410)	BICARBONATE (HCO3) (MG/L) (00440)	CARBONATE (CO3) (MG/L) (00445)
MAR.												
14...	1400	2	--	13.0	.47	--	1280	8.0	8.1	413	504	0
25...	1200	2	--	9.5	.20	--	1280	7.7	16	414	505	0
APR.												
04...	1215	2	--	8.5	--	.38	1290	7.9	10	413	504	0
19...	1200	2	--	9.0	--	.27	1280	7.9	10	422	514	0
27...	1430	2	--	14.0	--	1.1	1120	8.0	7.1	366	446	0
MAY												
03...	1400	2	--	17.0	--	1.3	1090	8.0	7.0	361	440	0
17...	1410	2	1880	14.5	--	2.0	1050	8.0	6.7	344	419	0
24...	1630	2	--	12.5	--	.94	797	8.0	5.2	268	327	0
30...	1525	2	--	14.0	--	1.0	1170	7.8	12	381	464	0

PROCESS DATE 09/03/74

09306242 - CORRAL GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED NITRITE PLUS NITRATE (N) (MG/L) (00631)	DIS-SOLVED ORTHO PHOS-PHATE (PO4) (MG/L) (00660)	DIS-SOLVED ORTHO, PHOS-PHORUS (P) (MG/L) (00671)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	SODIUM AD-SORP-TION RATIO (00931)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-STUM (K) (MG/L) (00935)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)
MAR.												
14...	.17	.15	.05	520	110	93	70	110	2.1	31	1.8	9.2
25...	.18	.12	.04	500	89	91	67	110	2.1	32	1.7	8.6
APR.												
04...	.18	.09	.03	510	100	92	69	110	2.1	32	1.4	8.7
19...	.21	.12	.04	510	86	93	67	110	2.1	32	1.4	8.4
27...	2.0	.09	.03	510	140	110	57	74	1.4	24	1.8	5.9
MAY												
03...	.91	.09	.03	440	81	83	57	87	1.8	30	1.7	8.0
17...	.97	.09	.03	430	88	79	57	80	1.7	29	1.3	6.6
24...	1.3	.09	.03	360	87	68	45	51	1.2	24	.7	6.0
30...	.52	.09	.03	460	84	82	63	97	2.0	31	1.5	7.7

PROCESS DATE 09/03/74

09306242 - CORRAL GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BARIUM (BA) (UG/L) (01005)	DIS-SOLVED BERYL-LIUM (BE) (UG/L) (01010)	DIS-SOLVED BISMUTH (BI) (UG/L) (01015)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CAD-MIUM (CD) (UG/L) (01025)	DIS-SOLVED CHRO-MIUM (CR) (UG/L) (01030)	DIS-SOLVED COBALT (CO) (UG/L) (01035)	DIS-SOLVED COPPER (CU) (UG/L) (01040)
MAR.												
14...	340	.5	19	--	--	--	--	--	--	--	--	--
25...	320	.6	20	--	--	--	--	--	--	--	--	--
APR.												
04...	320	.5	20	2	--	--	--	--	1	--	--	--
19...	360	1.1	23	5	--	--	--	--	2	--	--	--
27...	270	.4	23	--	--	--	--	--	--	--	--	--
MAY												
03...	250	.4	23	--	--	--	--	--	--	--	--	--
17...	230	.4	22	10	120	<5	<9	90	2	<6	<13	<3
24...	160	.4	24	4	0	--	--	80	1	--	--	13
30...	280	.4	23	5	100	--	--	120	1	--	--	2

PROCESS DATE 09/03/74

09306242 - COKRAL GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED IRON (FE) (UG/L) (01046)	DIS-SOLVED LEAD (PB) (UG/L) (01049)	DIS-SOLVED MANGANESE (MN) (UG/L) (01056)	DIS-SOLVED MOLYBDENUM (MO) (UG/L) (01060)	DIS-SOLVED NICKEL (NI) (UG/L) (01065)	DIS-SOLVED SILVER (AG) (UG/L) (01075)	DIS-SOLVED STRONTIUM (SR) (UG/L) (01080)	DIS-SOLVED VANADIUM (V) (UG/L) (01085)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)	DIS-SOLVED TIN (SN) (UG/L) (01100)	DIS-SOLVED ALUMINUM (AL) (UG/L) (01106)
MAR.											
14...	60	--	30	--	--	--	--	--	--	--	--
25...	90	--	20	--	--	--	--	--	--	--	--
APR.											
04...	40	--	38	--	--	--	--	--	--	--	--
19...	30	--	10	--	--	--	--	--	--	--	--
27...	130	--	0	--	--	--	--	--	--	--	--
MAY											
03...	40	--	0	--	--	--	--	--	--	--	--
17...	70	<13	0	35	<6	<2	1300	<6.0	77	<9	60
24...	30	2	0	--	--	--	--	--	10	--	--
30...	40	8	0	--	--	--	--	--	10	--	--

PROCESS DATE 09/03/74

09306242 - CORRAL GULCH NEAR RANGELY, CO. DISTRICT CODE 08

WATER QUALITY DATA, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DATE	DIS-SOLVED GALLIUM (GA) (UG/L) (01120)	DIS-SOLVED GER-MANIUM (GE) (UG/L) (01125)	DIS-SOLVED LITHIUM (LI) (UG/L) (01130)	DIS-SOLVED SELE-NIUM (SE) (UG/L) (01145)	DIS-SOLVED TI-TANIUM (TI) (UG/L) (01150)	DIS-SOLVED ZIR-CONIUM (ZR) (UG/L) (01160)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	DIS-SOLVED SOLIDS (TONS PER AC-FT) (70303)	DIS-SOLVED MERCURY (HG) (UG/L) (71890)	ELEV. OF LAND SURFACE DATUM (FT. ABOVE MSL) (72000)
MAR.											
14...	--	--	--	--	--	--	893	1.13	1.21	--	6580
25...	--	--	--	--	--	--	869	.47	1.18	--	6580
APR.											
04...	--	--	--	--	--	--	871	.89	1.18	.2	6580
19...	--	--	--	?	--	--	918	.67	1.25	.0	6580
27...	--	--	--	--	--	--	771	2.44	1.05	--	6580
MAY											
03...	--	--	--	--	--	--	731	2.68	.99	--	6580
17...	<6	<13	9	7	<6	<20	687	3.82	.93	--	6580
24...	--	--	20	3	--	--	522	1.32	.71	.0	6580
30...	--	--	10	4	--	--	786	2.12	1.07	.0	6580

WELL COMPLETION REPORTS

8 Coreholes on Tract C-a

(1, 2-3, 4-5, 6, 7, 9 & 12)

by

WRIGHT WATER ENGINEERS, INC.

October 3, 1974

CORE HOLE NO. 1
COMPLETION REPORT

Dreiling Drilling Company of Denver, Colorado, rigged up on location CH-1 (NE, NW, Sec. 32, T1S, R99W) on August 10 and 11, 1974. Drilling commenced and 156 feet of surface casing was set on August 14, 1974. Coring began on August 14, 1974 with significant water production encountered at a depth of 420± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B groove" had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figures 3 and 4).

The core hole was completed by landing and cementing casing, after Birdwell Well Service Company ran a suite of geophysical logs on August 24, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and still well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the still well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-1 remained negligible until a depth of 420± feet was reached, at which time the well produced 40± gallons per minute (gpm). Production increased to 70 gpm at 440 feet, increased gradually to 100 gpm at

630 feet, a maximum for the upper aquifer. Production remained relatively stable from 630 to 820± feet, at which time a gradual increase began indicating the lower aquifer. Production increased to 155 gpm at 1000 feet, and decreased gradually to 100 gpm at 1240 feet, reaching a maximum for the lower aquifer of 190± gpm at 1300 feet.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals, a sample was tested for temperature, pH and conductivity. In addition, samples were collected at 200-foot intervals. Samples were also collected at four intervals: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove" and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 54°F to a high of 65°F.

Upper aquifer water temperatures ranged from 54° to 63°F to a depth of 850± feet. Combined aquifer water averaged 59°F below 850 feet.

The pH records show a high reading of 7.2 and a low of 6.4. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (See Figure 2) give values ranging from a low of 900 umhos/cm to a high of 4250 umhos/cm. The upper aquifer averaged approximately 1000 umhos/cm to 450 feet. The combined aquifer averaged approximately 2055 umhos/cm from 850 feet to total depth.

TABLE 1

WATER QUALITY CH-1

	Upper Aquifer (420' - 450')	Lower Aquifer (910' - 1404')
Conductivity (umhos/cm @ 25°C)		
High	1100	4250
Average	1000	2055
Low	900	950
Temperature (°F)		
High	63	65
Average	57	59
Low	54	54
pH		
High	7.0	7.2
Average	6.7	6.8
Low	6.4	6.4

The Industrial Laboratories Company analyzed the water samples which were collected, and have submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 485 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS
CH-1

	Upper Aquifer	Combined Aquifer
Production	65± gpm	170±
Static Water Level	248 feet	270±
Transmissivity	(Insufficient Data)	150 - 170 gpd/ft
Specific Capacity	0.43 gpm/ft of drawdown	0.18 gpm/ft of drawdown

The first recovery test does not provide sufficient data to permit calculations of the transmissivity. The recovery rate was too rapid to allow the pressure bomb to be set in the hole prior to the water reaching static level. The static water level is 248± feet, and the estimate of specific capacity (S.C. = 0.43) does seem realistic.

The second recovery tests provides estimates for all three aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. The second calculation of transmissivity (T_2 = 180 gpd/ft) also indicates pressuring up, and true leveling of the recovery did not occur prior to the end of the test. The calculated transmissivities and specific capacities, therefore, are conservative estimates.

PRODUCTION LOGGING

Birdwell Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the bore hole. The Temperature Log data are plotted on Figure 5. The Spinner Production Log,

which measures the velocity of nonpumping water in the bore hole has not been completely evaluated at this time. It does, however, show that the water movement in the bore hole is downward, thus recharging from the upper to lower aquifer.

Preliminary interpretation of the Prodution Log indicates major zones of water entry occur in the upper aquifer between 260 and 450 feet. The lower aquifer lies between 900 and 1404 feet, the interval in which water loss is taking place.

The static water level for the upper aquifer is approximately $250^{\pm}$ feet. The static water level for the combined aquifers is approximately $270^{\pm}$ feet. The differential in head (pressure) between the two aquifers results in the net downhole recharge into the lower aquifer.

SUMMARY AND CONCLUSIONS

Core Hole 1 was completed on August 24, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-1.

1. Static Water Levels
   - Upper Aquifer: $250^{\pm}$ (G.L.)
   - Combined Aquifer: $270^{\pm}$

2. Maximum Production
   - Upper Aquifer: <100 gpm
   - Combined Aquifer: <200 gpm

3. Transmissivity
   - Upper Aquifer: Insufficient Data
   - Combined Aquifer: 150 - 170 gpd/ft (conservative)

4. Specific Capacity
   - Upper Aquifer: 0.43 gpm/ft
   - Combined Aquifer: 0.18 gpm/ft

5. Water Quality

Upper Aquifer	- Specific Conductance	<1100 micromhos
	- Temperature	54 - 63°F
	- pH	6.4 - 7.0
Combined Aquifer	- Specific Conductance	<4250 micromhos
	- Temperature	54 - 65°F
	- pH	6.4 - 7.2

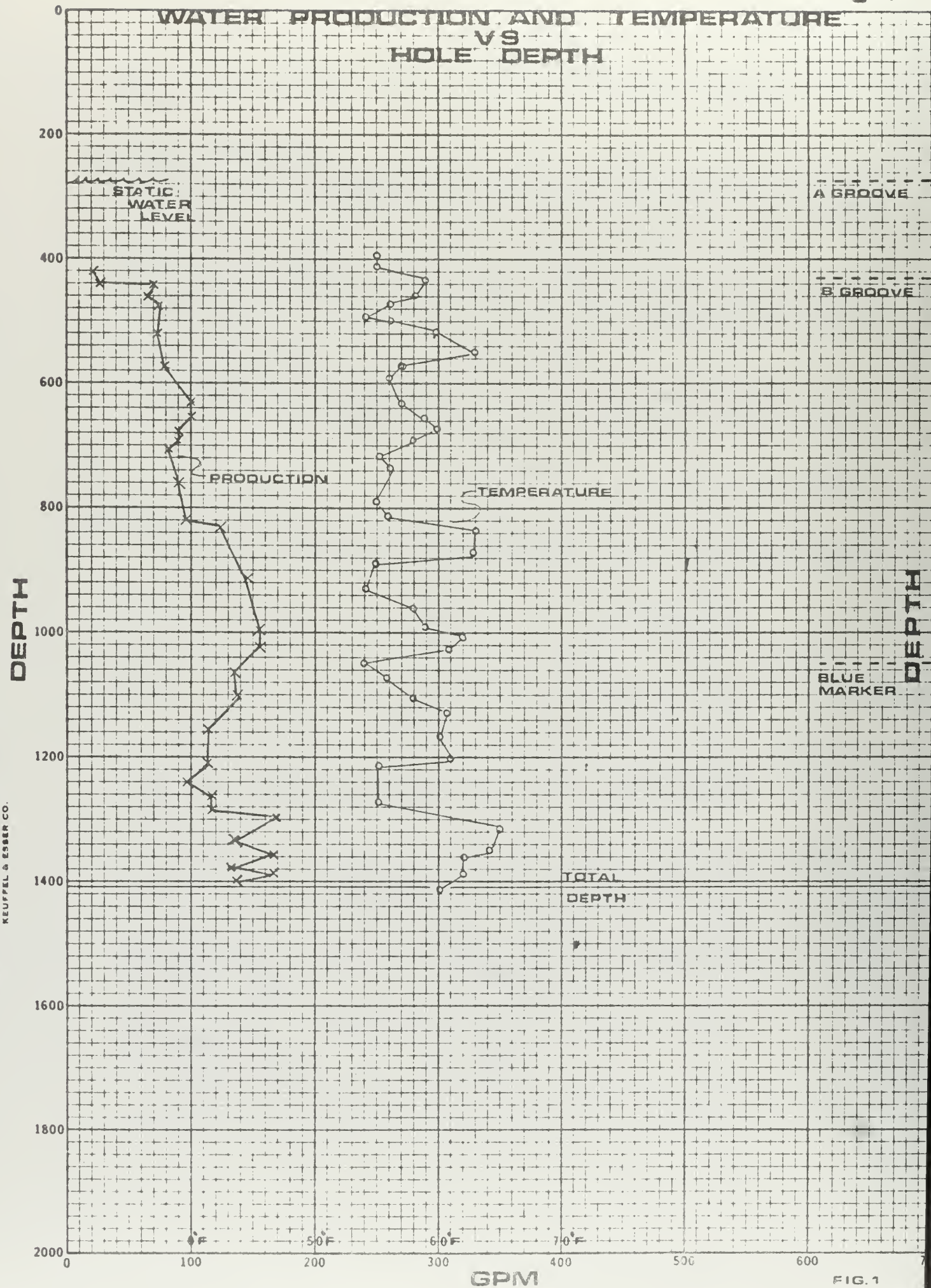

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
TOTAL DEPTH
DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
100
200
300
400
500
600
50°F
60°F
70°F
GPM
K&E 10 X 10 TO THE INCH 46 0703
7 X 10 INCHES
MADE IN U.S.A.
KEUFFEL & ESSER CO.

FIG. 1

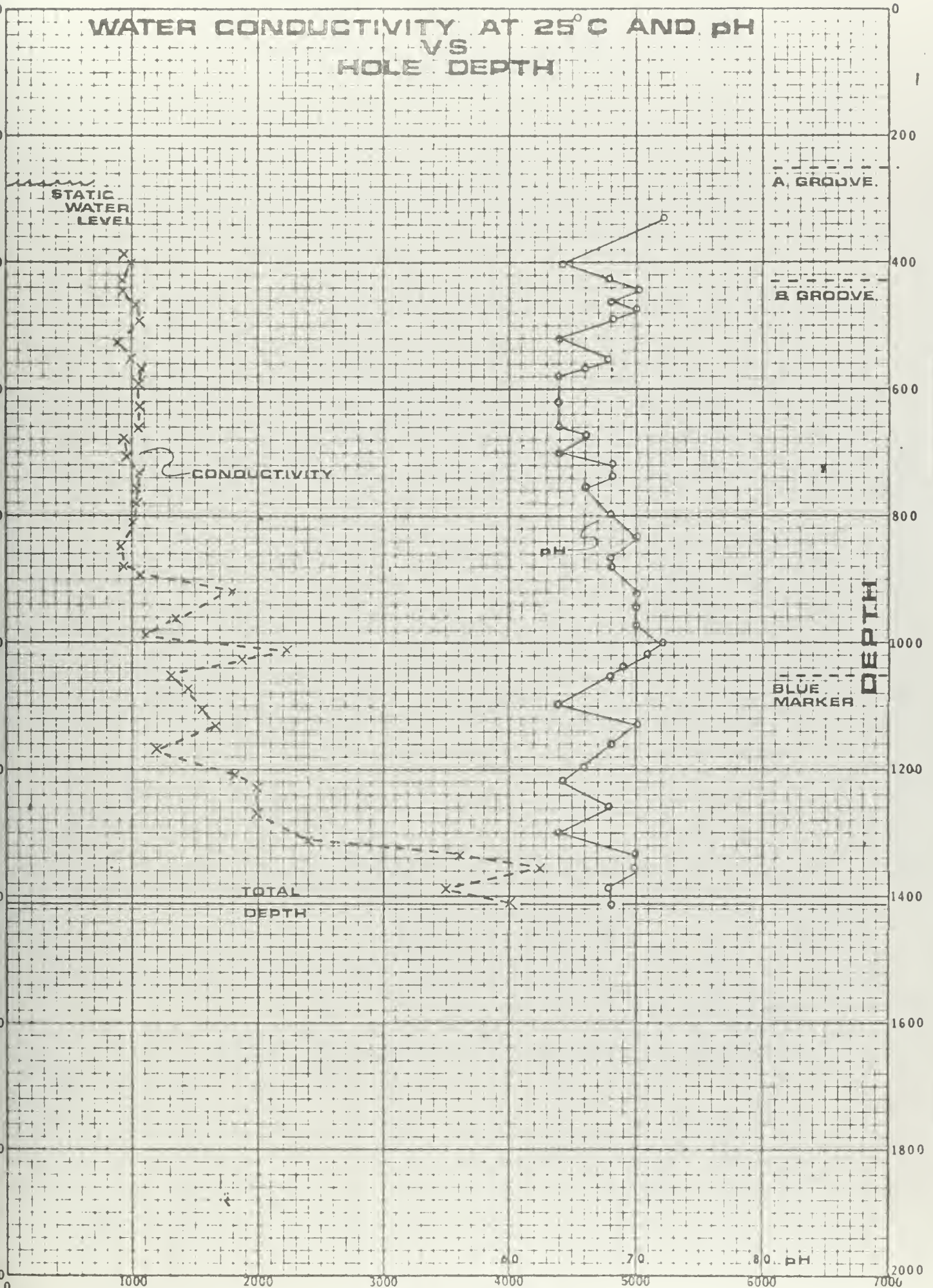

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
CONDUCTIVITY
pH
BLUE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1000
2000
3000
4000
5000
6000
7000
μ MHOS/CM
6.0
7.0
8.0 pH

FIG. 2

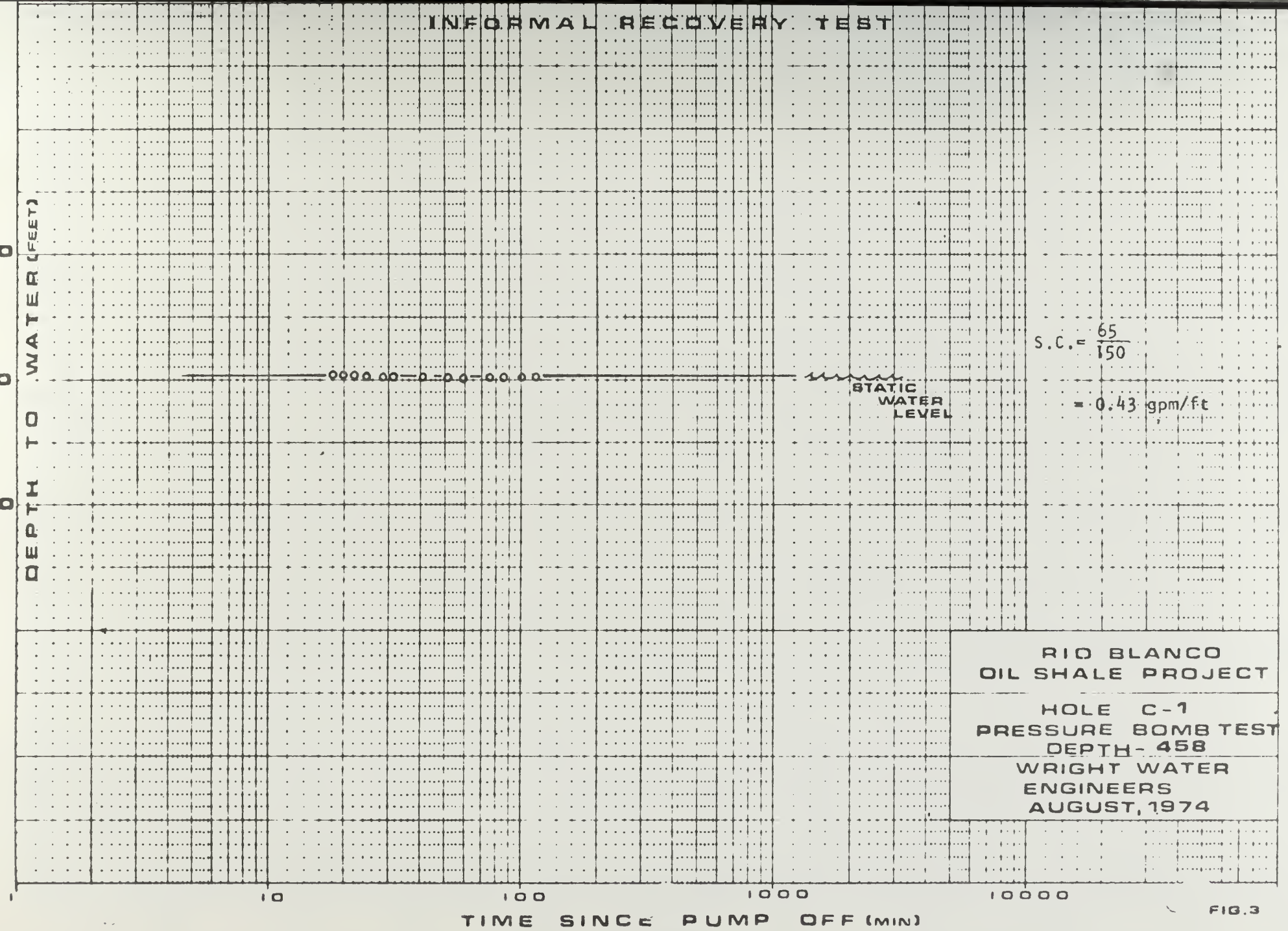
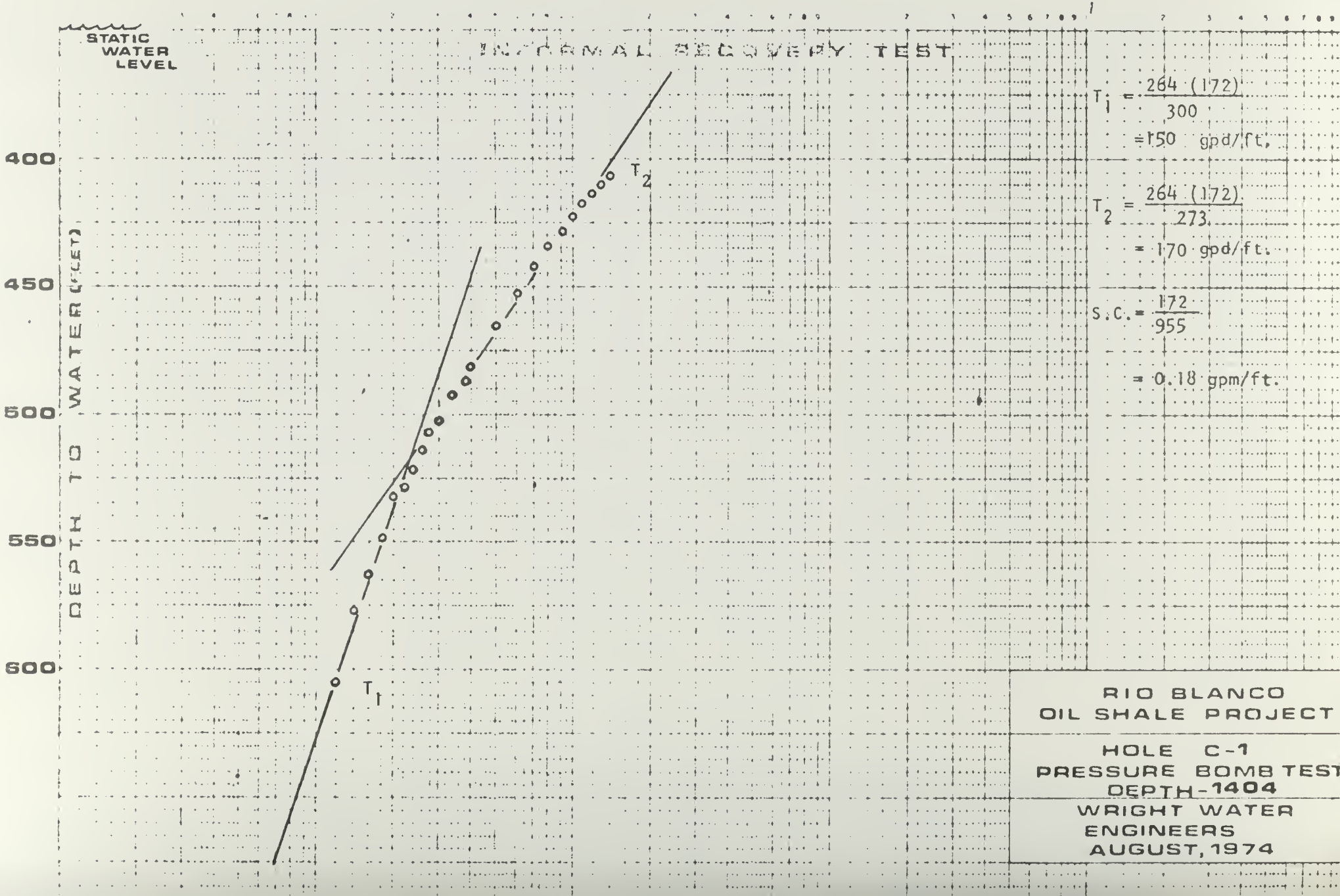


FIG.3

10 X 10 TO THE INCH 46 0703


STATIC WATER LEVEL
INFORMAL RECOVERY TEST
DEPTH TO WATER (FEET)
400
450
500
550
600
T_1
T_2
$T_1 = \frac{264\ (172)}{300}$
$= 150$ gpd/ft.
$T_2 = \frac{264\ (172)}{273}$
$= 170$ gpd/ft.
$S.C. = \frac{172}{955}$
$= 0.18$ gpm/ft.
RIO BLANCO
OIL SHALE PROJECT
HOLE C-1
PRESSURE BOMB TEST
DEPTH-1404
WRIGHT WATER
ENGINEERS
AUGUST, 1974

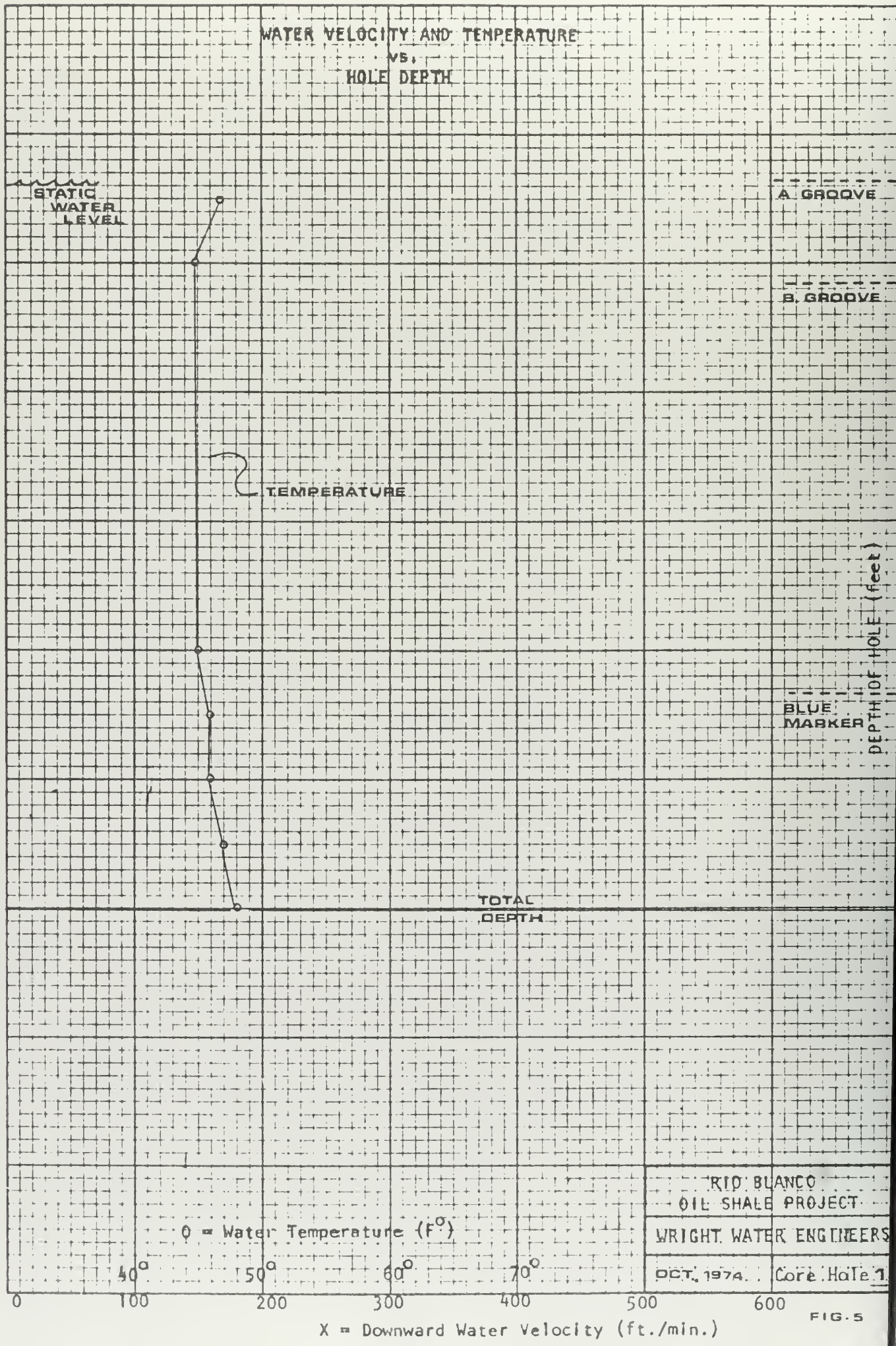


FIG. 5

K+E 46 0703 10 X 10 TO THE INCH 7 X 10 INCHES MADE IN U.S.A. KEUFFEL & ESSER CO.

CORE HOLE NO. 2-3

COMPLETION REPORT

Dreiling Drilling Company of Denver, Colorado, rigged up on location CH-2-3 (SW, NW, Sec. 33, T1S, R99W) on July 27, 1974. Drilling commenced and 155 feet of surface casing was set on July 29, 1974. Coring began on July 30, 1974 with significant water production encountered at a depth of 235± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B groove" had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figures 3 and 4).

The core hole was completed by landing and cementing casing, after Birdwell Well Service Company ran a suite of geophysical logs on August 10, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and still well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the still well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-2-3 remained negligible until a depth of 235± feet was reached, at which time the well produced 22± gallons per minute (gpm). Production increased to 180 gpm at 480 feet, decreased to 140 gpm at 540 - 580

feet, and reached a maximum for the upper aquifer of 195± gpm at 600 feet. Production remained stable from 600 to 920± feet, at which time the lower aquifer began producing. Production increased rapidly to 400 gpm at 1060 feet, and increased gradually to a maximum of 490± gpm at 1325 feet, stabilizing from that point to total depth.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals, a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals. Samples were also collected at four intervals: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove" and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 53°F to a high of 76°F.

Upper aquifer temperatures ranged from 53° to 65°F to a depth of 900± feet. Combined aquifer water averaged 71°F below 900 feet, with a distinct increase at the top of the lower aquifer (900± feet).

The pH records show a high reading of 7.8 and a low of 6.4. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 930 μmhos/cm to a high of 3600 μmhos/cm. The upper aquifer averaged approximately 1160 μmhos/cm to 475 feet. The combined aquifer averaged approximately 2760 μmhos/cm from 900 feet to total depth.

TABLE 1

WATER QUALITY CH-2-3

	Upper Aquifer (235' - 475')	Lower Aquifer (900' - 1424')
Conductivity (μmhos/cm at 25°C)		
High	1450	3600
Average	1160	2760
Low	930	1200
Temperature (°F.)		
High	65	76
Average	59	71
Low	53	59
pH		
High	7.4	7.8
Average	7.0	7.4
Low	6.4	6.8

K+E 46 0703 MADE IN U.S.A. 10 X 10 TO THE INCH 7 X 10 INCHES

The Industrial Laboratories Company analyzed the water samples which were collected, and have submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 456 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS
CH-2-3

	Upper Aquifer	Combined Aquifers
Production	180± gpm	490± gpm
Static Water Level	120± feet	180± feet
Transmissivity	3000± gpd/ft	550 - 1800 gpd/ft
Specific Capacity	1.7 gpm/ft of drawdown	0.85 gpm/ft of drawdown

The first recovery test provides realistic estimates for all three aquifer characteristics. The transmissivity of T = 3000 gpd/ft. correlates well with water production in the upper aquifer. The specific capacity (S.C. = 1.7 gpm/ft) also correlates with production and is a realistic estimate.

The second recovery test provides anomalous estimates for the aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. It also is rather anomalous in that the sharp break in slope indicates that a boundary effect is present in the vicinity of the well, adding to the rapid recovery. The second calculation of transmissivity (T_2 = 1,800 gpd/ft) is a more accurate indication of combined aquifer potential. The specific capacity (S.C. = 0.85 gpm/ft) correlates with production and is a realistic estimate.

The second plot of recovery data, therefore, does not realistically represent the combined aquifer potential. The transmissivity of the combined aquifer should be near the same magnitude or greater than that for the upper aquifer alone.

PRODUCTION LOGGING

Birdwell Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the bore hole. The Temperature Log data are plotted on Figure 5. The Spinner Production Log, which measures the velocity of nonpumping water in the bore hole has not been completely evaluated at this time. It does, however, show that the water movement in the bore hole is downward, thus recharging from the upper to lower aquifer.

Preliminary interpretation of the Production Log indicates major zones of water entry occur in the upper aquifer between 160 and 470 feet. The lower aquifer lies between 1000 and 1300 feet, the interval in which water loss is taking place.

The static water level for the upper aquifer is approximately $120^{\pm}$ feet. The static water level for the combined aquifers is approximately $180^{\pm}$ feet. The differential in head (pressure) between the two aquifers results in the net downhole recharge into the lower aquifer.

SUMMARY AND CONCLUSIONS

Core Hole 2-3 was completed on August 10, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-2-3:

1.	Static Water Levels		
	Upper Aquifer		$120^{\pm}$ (G.L.)
	Combined Aquifer		$180^{\pm}$ (G.L.)
2.	Maximum Production		
	Upper Aquifer		<200 gpm
	Combined Aquifer		$<600^{\pm}$ gpm
3.	Transmissivity		
	Upper Aquifer		$3000^{\pm}$ gpd/ft
	Combined Aquifer		550 - 1800 gpd/ft
4.	Specific Capacity		
	Upper Aquifer		1.7 gpm/ft
	Combined Aquifer		0.85 gpm/ft
5.	Water Quality		
	Upper Aquifer	- Specific Conductance	< 1450 micromhos
		- Temperature	53-65°F
		- pH	6.4 - 7.4
	Combined Aquifer	- Specific Conductance	< 3600 micromhos
		- Temperature	59-76°F
		- pH	6.8 - 7.8

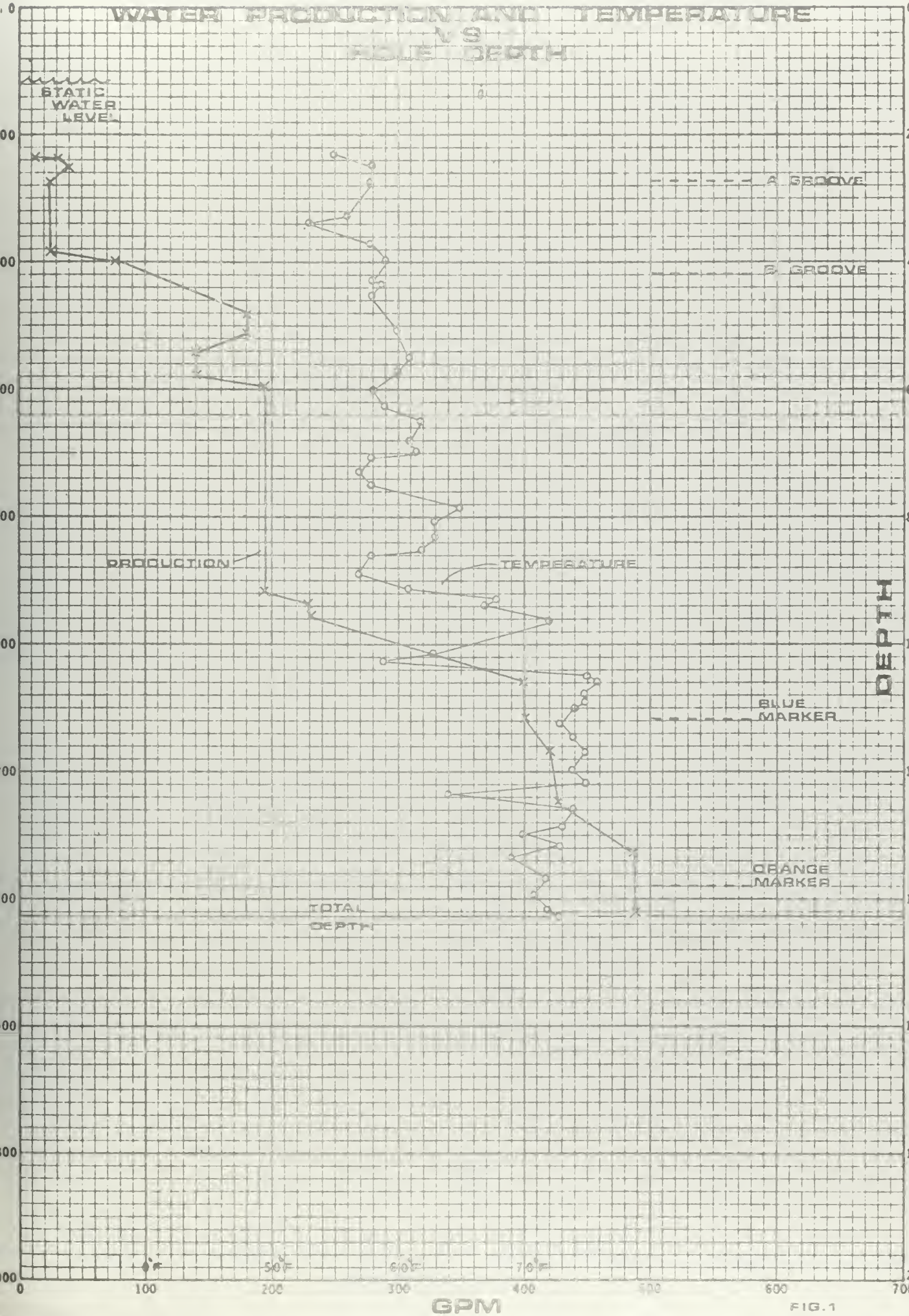
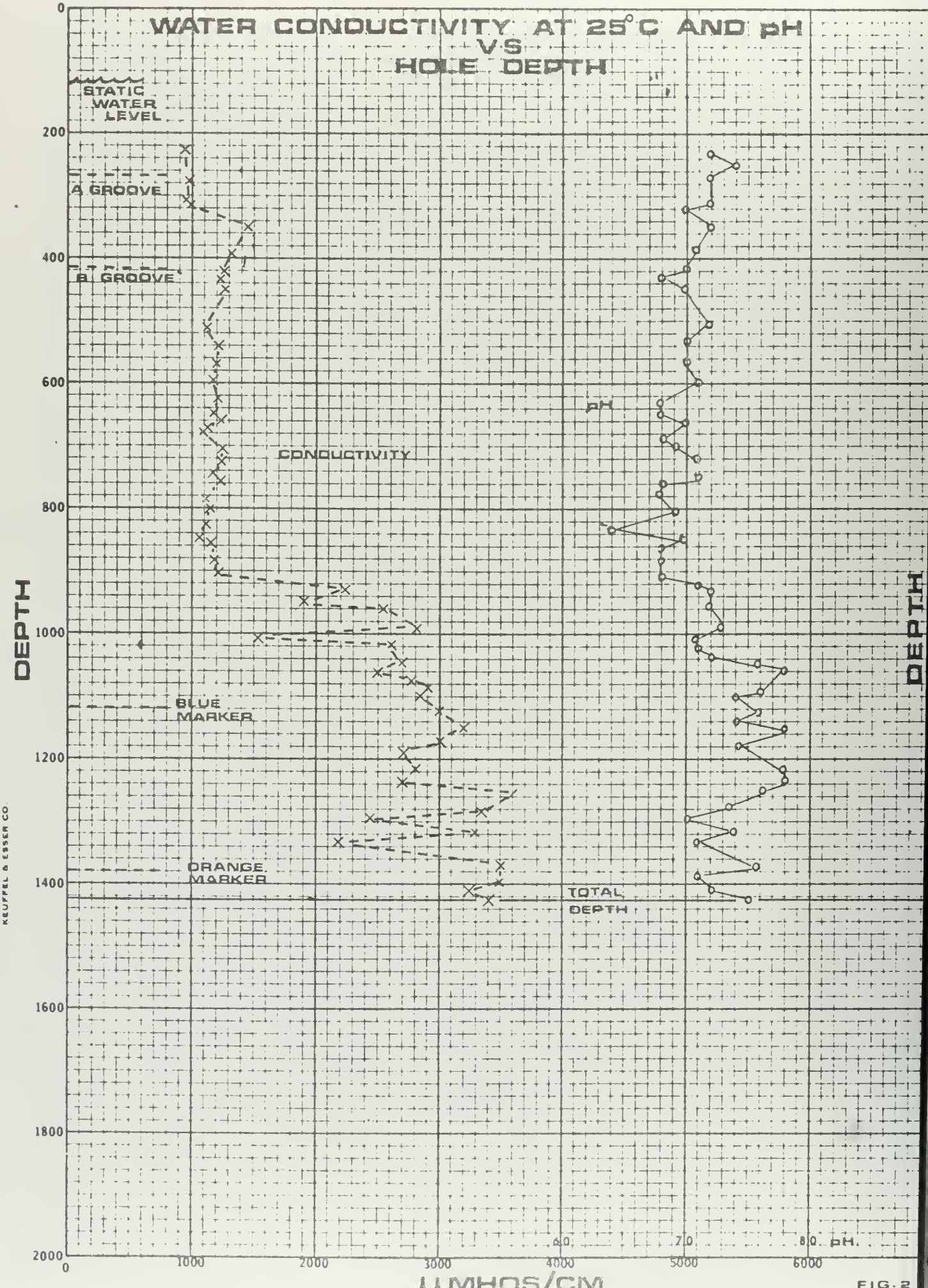

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50°F
60°F
70°F
0
100
200
300
400
500
600
700
GPM

FIG. 1



K•E 10 X 10 TO THE INCH 48 0703
7 X 10 INCHES
KEUFFEL & ESSER CO.

FIG-2

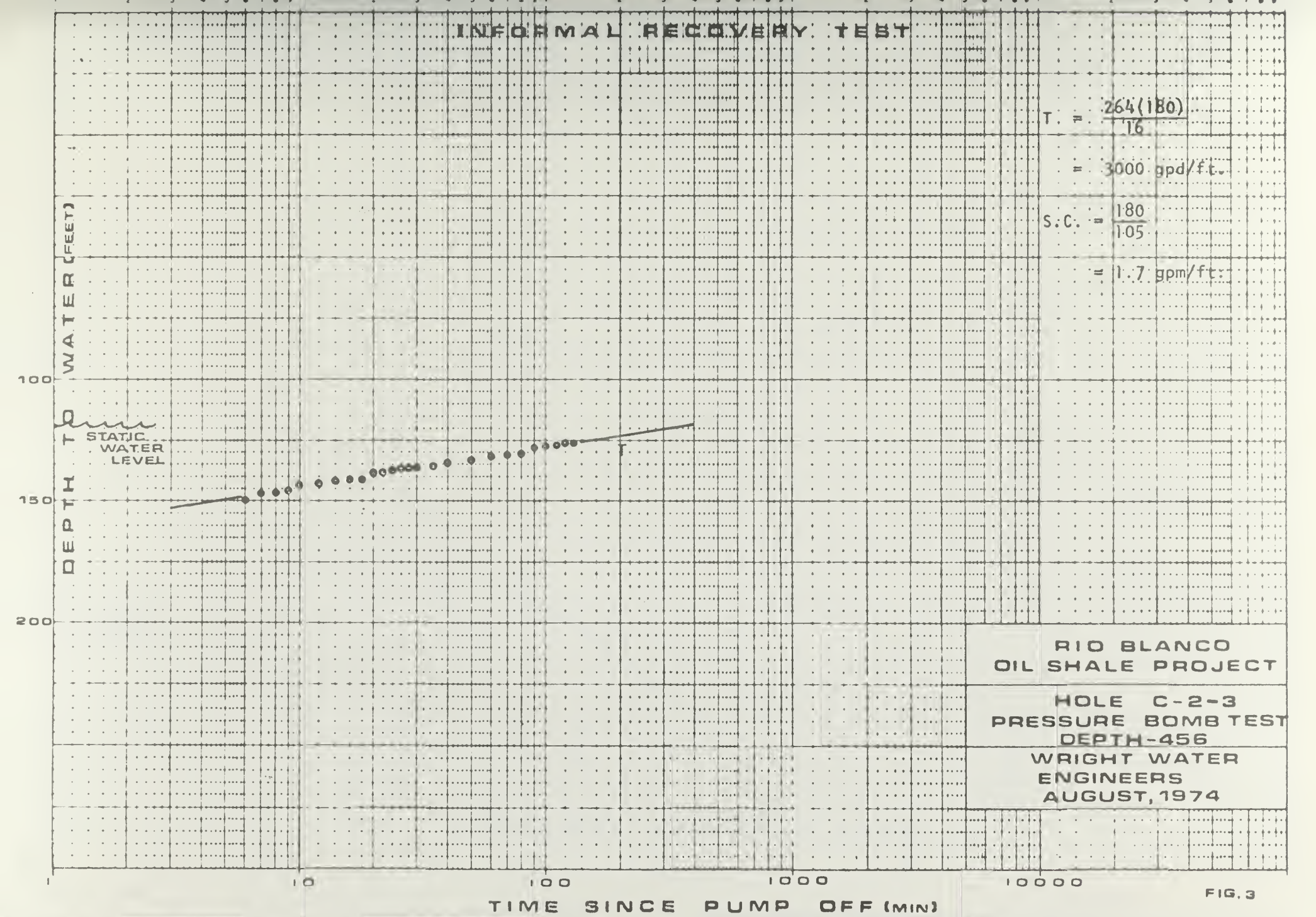
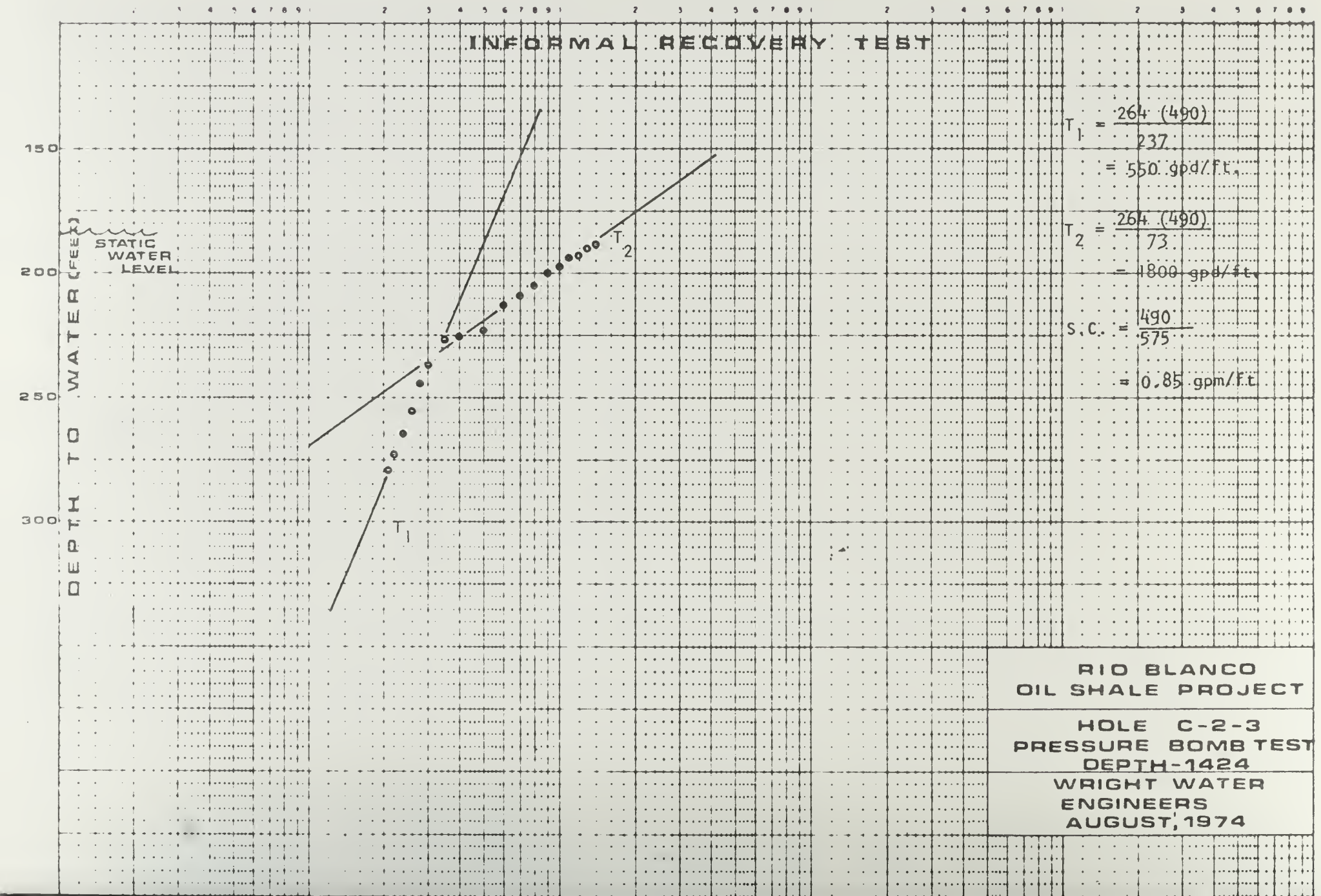

INFORMAL RECOVERY TEST
T. = 264(180) / 16
= 3000 gpd/ft.
S.C. = 180 / 105
= 1.7 gpm/ft.
DEPTH TO WATER (FEET)
100
150
200
STATIC WATER LEVEL
1
10
100
1000
10000
TIME SINCE PUMP OFF (MIN)
RIO BLANCO
OIL SHALE PROJECT
HOLE C-2-3
PRESSURE BOMB TEST
DEPTH-456
WRIGHT WATER
ENGINEERS
AUGUST, 1974

FIG. 3

10 X 10 TO THE INCH 46 0703



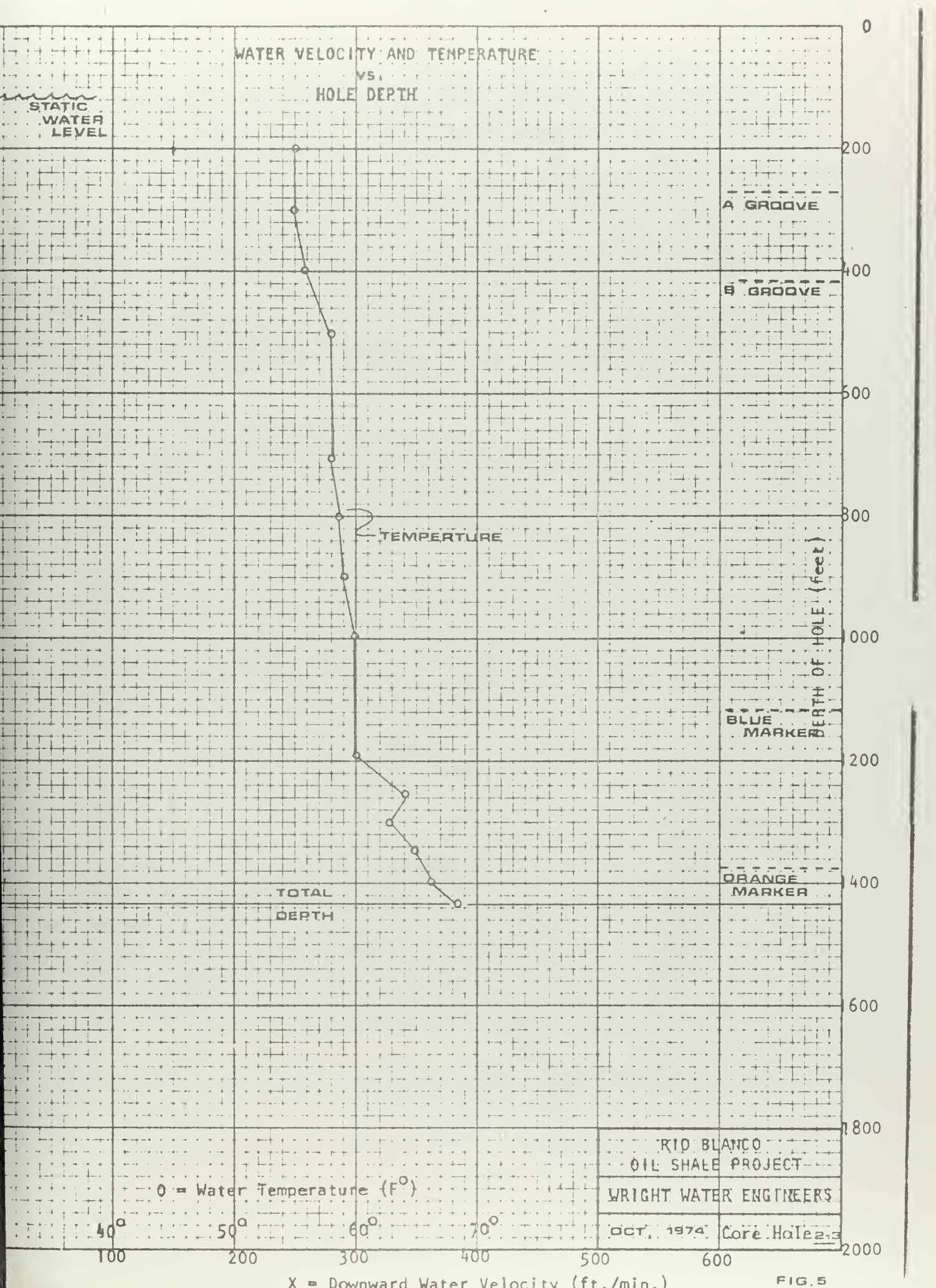

WATER VELOCITY AND TEMPERATURE
vs.
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
TEMPERTURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH OF HOLE (feet)
0
200
400
600
800
000
200
400
600
1800
2000
100
200
300
400
500
600
40°
50°
60°
70°
O = Water Temperature (F°)
X = Downward Water Velocity (ft./min.)
RIO BLANCO OIL SHALE PROJECT
WRIGHT WATER ENGINEERS
OCT. 1974
Core Hole 2-3

FIG. 5

CORE HOLE NO. 4-5
COMPLETION REPORT

Carmack Drilling Company of Grand Junction, Colorado, rigged up on location CH-4-5 (SE, NW, Sec. 34 T1S, R99W) on August 10, 1974. Drilling commenced and 153 feet of surface casing was set on August 16, 1974. Coring began on August 17, 1974 with significant water production encountered at a depth of 230± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by the Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B" groove had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figure 3 and 4).

The corehole was completed by landing and cementing casing, after Birdwell Well Service Company ran a suite of geophysical logs on September 1, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virture of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-4-5 remained negligible until a depth of 220± feet was reached, at which time the well produced 22± gallons per minute (gpm).

Production increased steadily to 100 gpm at 370 feet, rose sharply to 300± gpm at 440 feet, and gradually increased to an upper aquifer peak of 570± gpm at 730 feet. Production ranged from 570 to 520 gpm to a depth of 1230 feet, at which time the lower aquifer was encountered. Production increased rapidly to 700 gpm at 1330 feet, and reached a maximum of 850± gpm at total depth.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals. Samples were also collected at four intervals, and sent to The Industrial Laboratories Company of Denver, for complete analysis: 1)at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove", and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 53° to a high of 82°F.

Upper aquifer temperatures ranged from 53° to 66°F to a depth of 1180± feet. Combined aquifer water averaged 76°F below 1180 feet, with a distinct increase at the top of the lower aquifer (1240± feet).

The pH records show a high reading of 7.8 and a low of 6.2. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 980 μmhos/cm to a high of 3384 μmhos/cm The upper aquifer averaged approximately 1210 μmhos/cm to 650 feet. The combined aquifer averaged approximately 2850 μmhos/cm from 1180 feet to total depth.

TABLE 1

WATER QUALITY CH-4-5

	Upper Aquifer (202' - 650')	Lower Aquifer (1180' - 1663')
Conductivity (μmhos/cm @ 25°C)		
High	1340	3384
Average	1210±	2850±
Low	980	1090
Temperature (°F)		
High	66	82
Average	60	76
Low	53	65
pH		
High	7.2	7.8
Average	6.7	7.5
Low	6.2	7.0

The Industrial Laboratories Company analysed the water samples which were collected and have submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 618 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS

CH-4-5

	Upper Aquifer	Combined Aquifers
Production	360± gpm	850± gpm
Static Water Level	40± feet	65± feet
Transmissivity	6800 ± gpd/ft.	11,800 ± gpd/ft.
Specific Capacity	3.6 gpm/ft of drawdown	6.4 gpm/ft of drawdown

The first recovery test provides realistic estimates for all three aquifer characteristics. A transmissivity of 6800 correlates well with production, as does a specific capacity of 3.6 gpm/ft.

The second recovery test also yields realistic aquifer characteristics. Both a transmissivity of 11,800 gpd/ft and a specific capacity of 6.4 gpm/ft. correlate well with production data.

PRODUCTION LOGGING

Birdwell Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the borehole. The Temperature Log data are plotted on Figure 5. The Spinner Production Log, which measures the velocity of nonpumping water in the bore hole, has not been complete evaluated at this time. It does, however, show that the water movement in the bore hole is upward, thus recharging from the lower to upper aquifer. Plots of the interpretation of this data will be available as soon as completed.

SUMMARY AND CONCLUSIONS

Core Hole 4-5 was completed on September 1, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-4-5.

1. Static Water Levels
   - Upper Aquifer: 40± (G.L.) (at T.D. = 618')
   - Combined Aquifer: 65± (G.L.)

2. Maximum Production
   - Upper Aquifer: 400± gpm
   - Combined Aquifer: 850± gpm

3. Transmissivity
   - Upper Aquifer: 6800± gpd/ft
   - Combined Aquifer: 11,800 gpd/ft

4. Specific Capacity
   - Upper Aquifer: 3.6 gpm/ft
   - Combined Aqufier: 6.4 gpm/ft

5. Water Quality
   - Upper Aquifer
     - Specific Conductance: < 1340 micromhos
     - Temperature: 53-66°F
     - pH: 6.2 - 7.2
   - Combined Aquifer
     - Specific Conductance: < 3384 micromhos
     - Temperature: 65-82°F
     - pH: 7.0 - 7.8

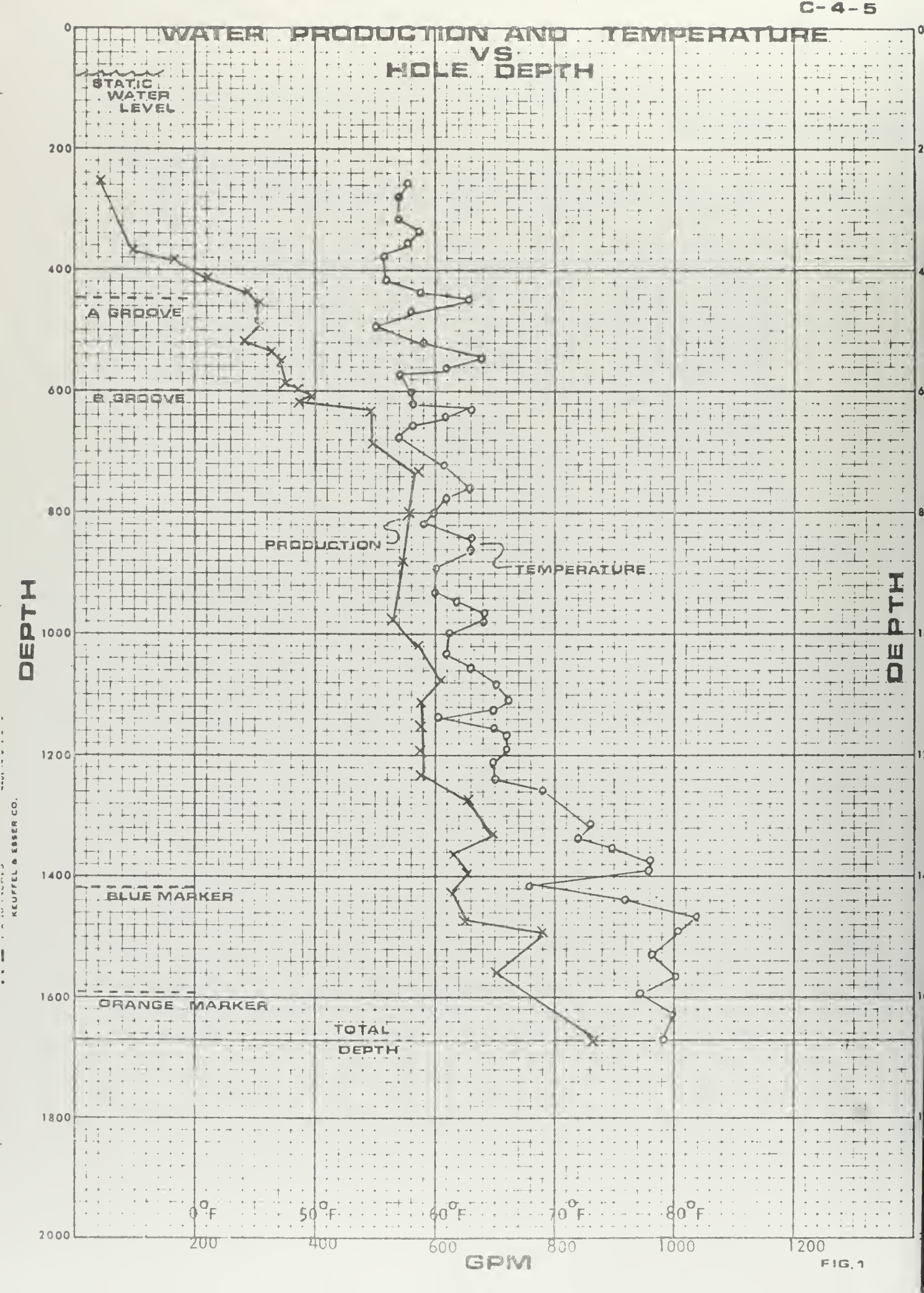

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0°F
50°F
60°F
70°F
80°F
200
400
600
800
1000
1200
GPM
KEUFFEL & ESSER CO.

FIG. 1

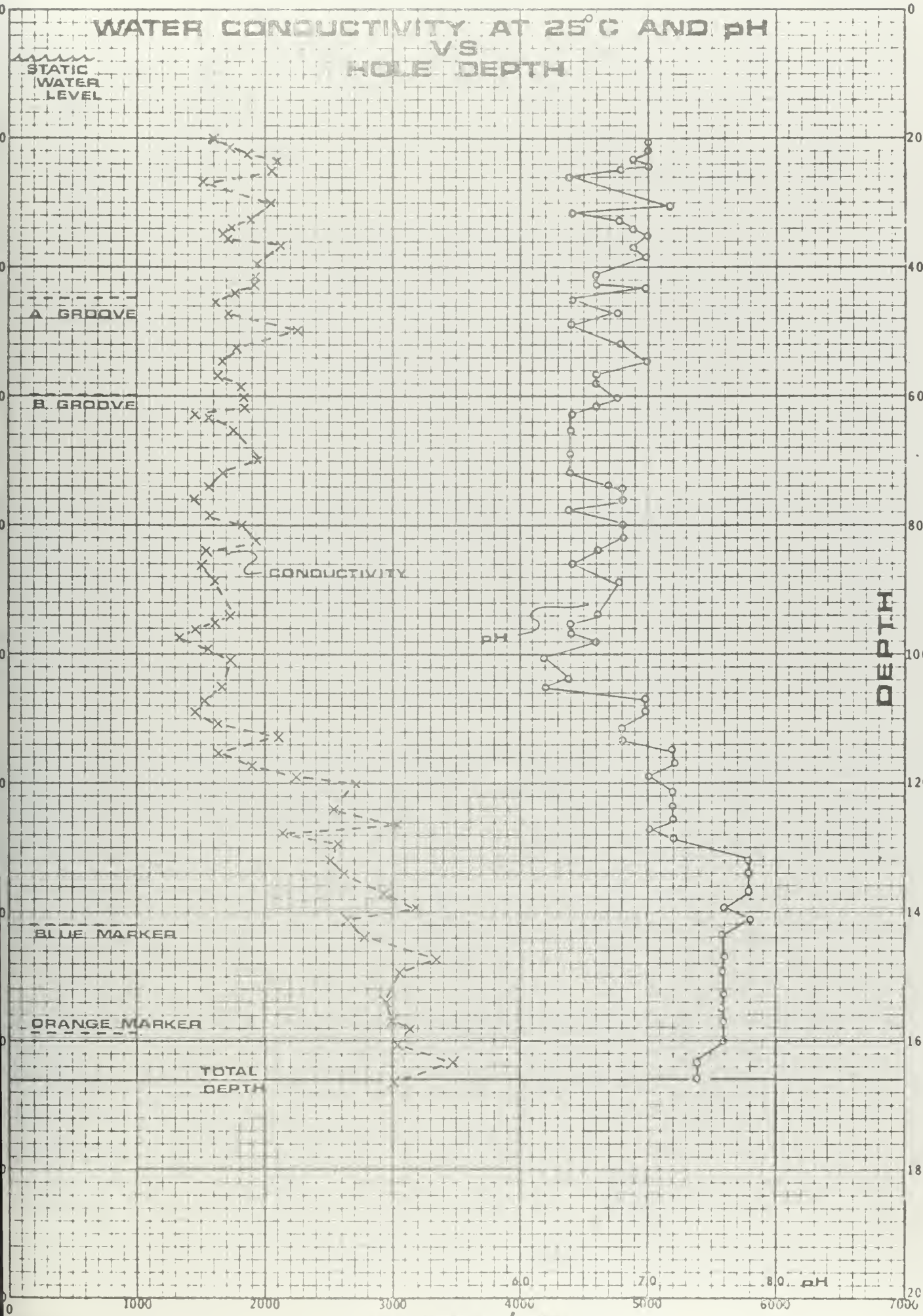
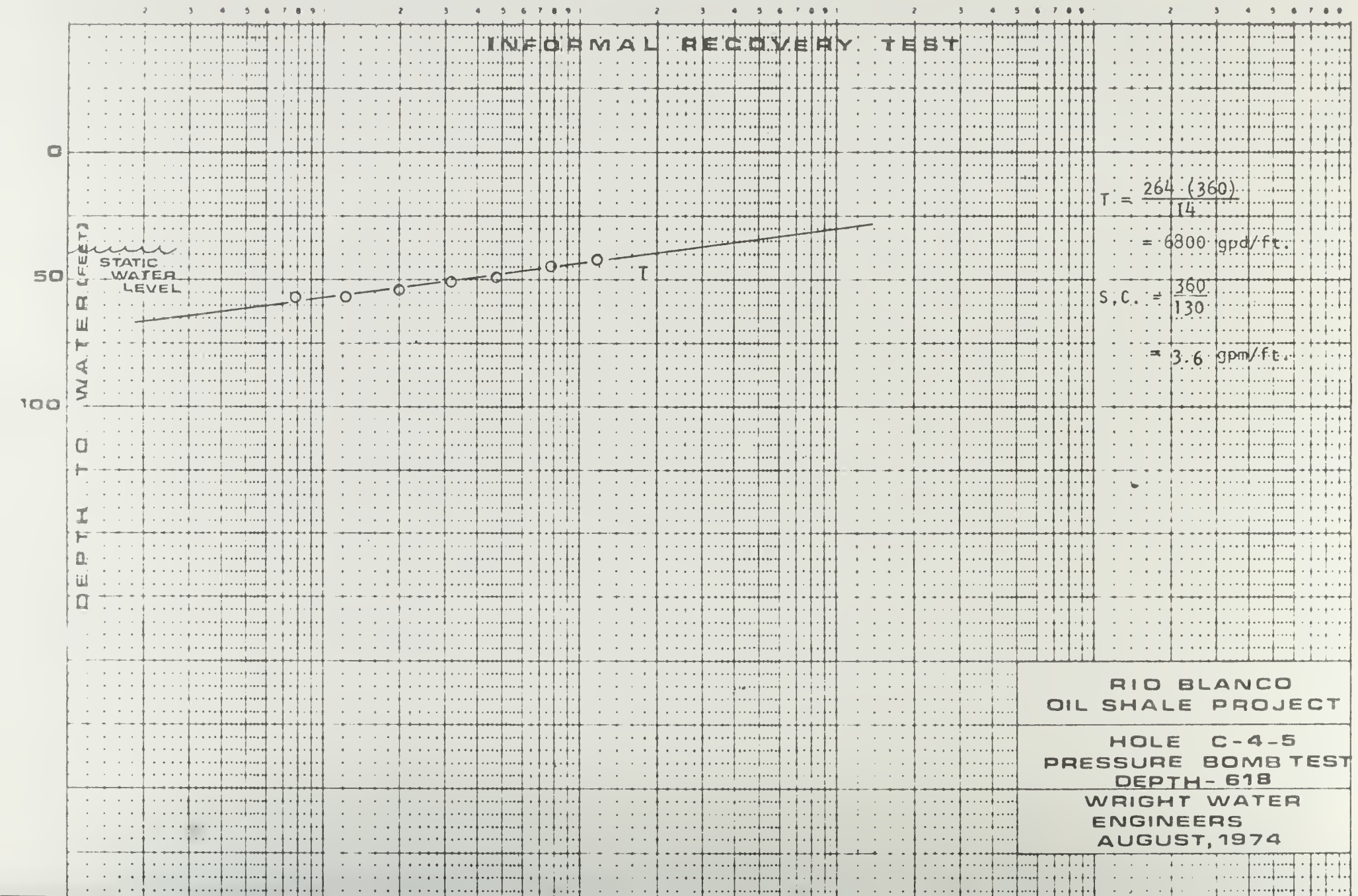

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
CONDUCTIVITY
pH
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
6.0
7.0
8.0
pH
0
1000
2000
3000
4000
5000
6000
7000
μ MHOS/CM

FIG. 2

KEUFFEL & ESSER CO.



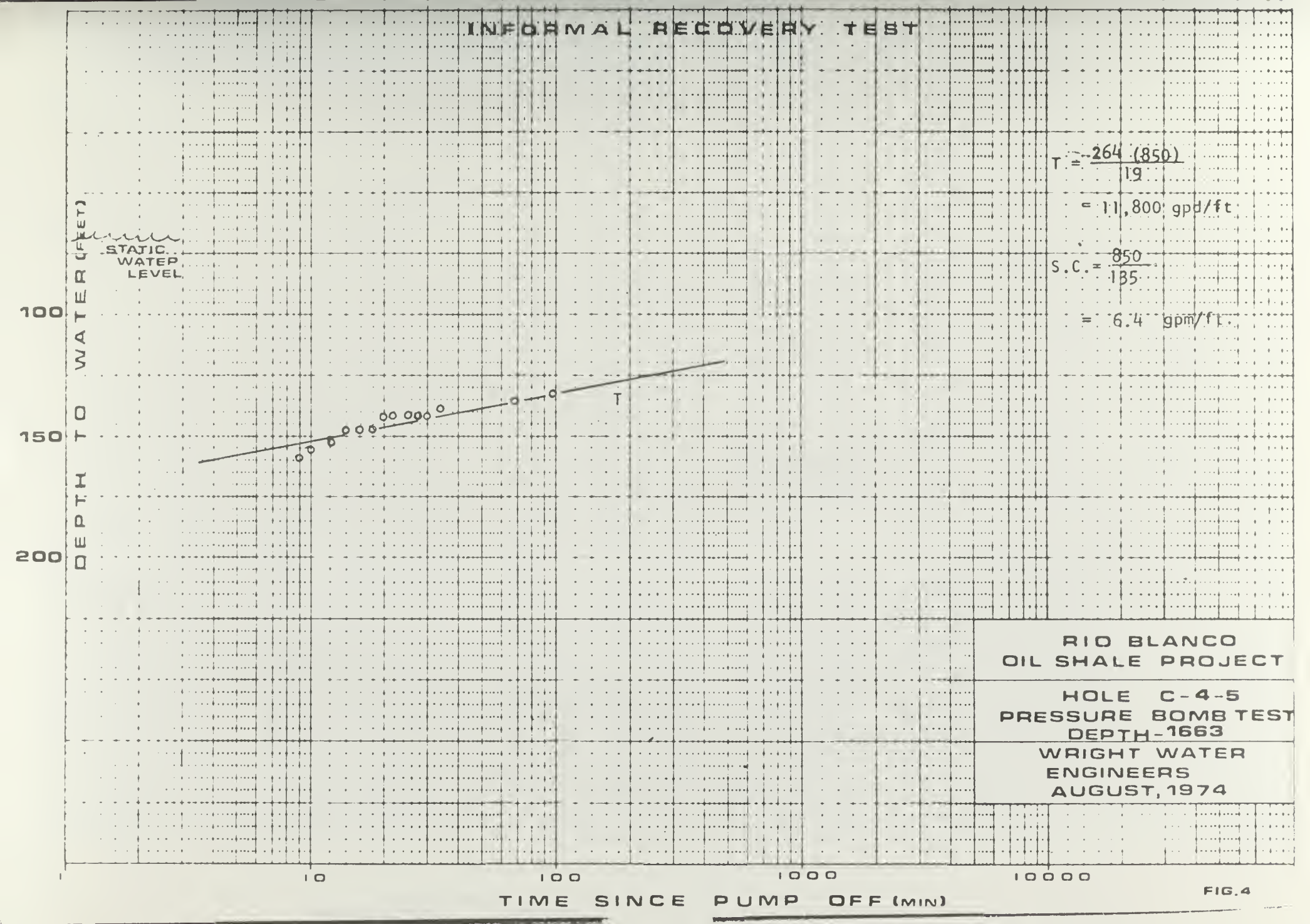
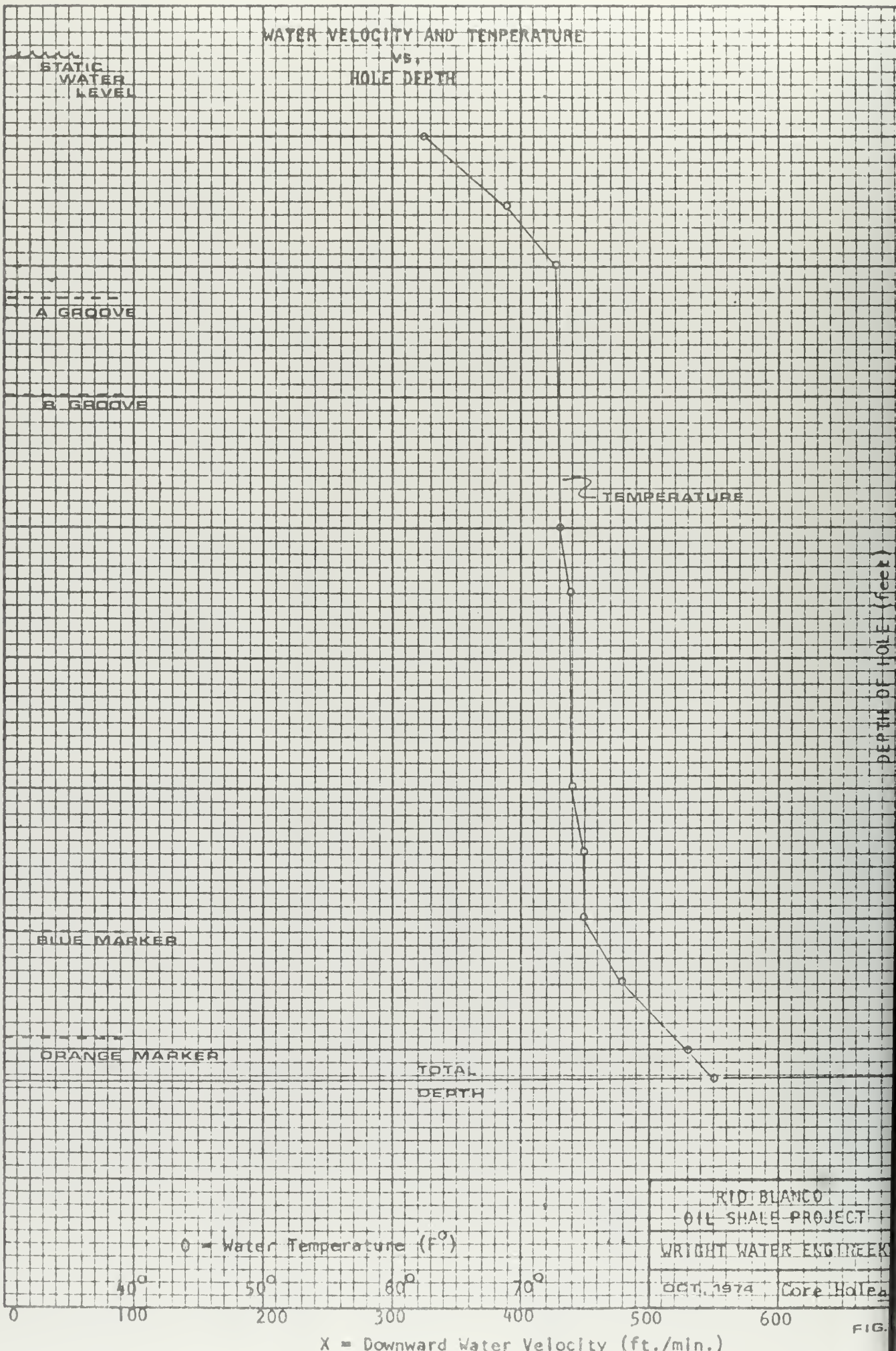

INFORMAL RECOVERY TEST
DEPTH TO WATER (FEET)
STATIC WATER LEVEL
100
150
200
T
$T = \frac{264\ (850)}{19}$
= 11,800 gpd/ft
$S.C. = \frac{850}{135}$
= 6.4 gpm/ft.
RIO BLANCO
OIL SHALE PROJECT
HOLE C-4-5
PRESSURE BOMB TEST
DEPTH-1663
WRIGHT WATER
ENGINEERS
AUGUST, 1974
1
10
100
1000
10000
TIME SINCE PUMP OFF (MIN)

FIG.4



K&E 10 X 10 TO THE INCH 46 0703
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

CORE HOLE NO. 6
COMPLETION REPORT

Drelling Drilling Company of Denver, Colorado, rigged up on location CH-6 (SE, SE, Sec. 34 T1S, R99W) on July 3, 1974. Drilling commenced and 160 feet of surface casing was set on that date. Coring began on July 4, 1974 with significant water production encountered at a depth of 180± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B" groove had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figures 3 and 4).

The corehole was completed by landing and cementing casing, after Schlumberger Well Service Company ran a suite of geophysical logs on July 23, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenth of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-6 remained negligible until a depth of 180± feet was reached, at which time the well produced 22± gallons per minute (gpm). Production increased steadily to 375 gpm at 685± feet, with three minor decreases noted at 360 - 380 feet, 500 - 520 feet, and 640 - 680 feet. A general decrease in production was then encountered from 375 gpm to 245± gpm at 1055 feet A sharp decrease at 1060 feet (to 180 gpm), an increase to 285 gpm at 1150 feet,

and additional loss to 168± gpm at 1320 feet followed. Between 1320 feet and 1460 feet, production increased rapidly to 550± gpm. This increase was due to the penetration of the lower aquifer. From 1460 feet to total depth, production varied from 475 gpm to a maximum of 570 gpm at 1695 feet.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thrity-foot intervals a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals and tested for dissolved oxygen content and chlorine content. Samples were also collected at four intervals, and sent to The Industrial Laboratories Company of Denver, for complete analysis: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove", and 4) at total depth. Table I below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 57°F to a high of 81°F.

Upper aquifer temperatures ranged from 57° - 66°F to a depth of 1300± feet. Combined aquifer water averaged 75°F below 1300 feet, with a distinct increase at the top of the lower aquifer (1310± feet).

The pH records show a high reading of 8.5 and a low of 6.8. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 978 μmhos/cm to a high of 4000 umhos/cm The upper aquifer averaged approximately 1200 μmhos/cm to 630 feet. The combined aquifer averaged approximately 2840 μmhos/cm from 1300 feet to total depth.

TABLE I.

WATER QUALITY CH-6

	Upper Aquifer (180' - 630')	Lower Aquifer (1300' - 1780')
Conductivity (μmhos/cm @ 25°C)		
High	1500	4000
Average	1200±	2840
Low	978	1050
Temperature (°F.)		
High	66	81
Average	62	75
Low	57	62
pH		
High	8.5	8.5
Average	7.6	7.9
Low	6.8	7.6

The Industrial Laboratories Company analyzed the water samples which were collected, and submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 767 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS

CH-6

	Upper Aquifer	Combined Aquifers
Production	300± gal. per min.	530± gal. per min.
Static Water Level	40± feet	< 200 feet
Transmissivity	175 - 19,800 gpd/ft	365± gpd/ft
Specific Capacity	.50 gpm/ft of drawdown	0.24 gpm/ft of drawdown

The first recovery test provides realistic estimates for all three aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. It also is rather anomalous in that the sharp break in slope indicates that a boundary effect is present in the vicinity of the well, adding to the rapid recovery. The second calculation of transmissivity (T_2 = 19,800 gpd/ft) therefore, is a more accurate indication of upper aquifer potential. The specific capacity (S.C. =0.50 gpm/ft) correlates with production and is also a realistic estimate.

The second recovery test yields an anomalously low transmissivity. The recorder had a maximum of 500 psi capability, which was overcome by the total head of recovery at about 90 minutes after shutdown.

The plot of recovery data, therefore, does not realistically represent the combined aquifer potential. The transmissivity of the combined aquifer should be near the same magnitude as that for the upper aquifer alone. The specific capacity is a reliable figure for the combined aquifers.

PRODUCTION LOGGING

Schlumberger Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the borehole. The Temperature Log data are plotted on Figure 5. The Engineered Production Log, which measures the velocity of nonpumping water in the borehole, is also plotted on Figure 5. The value of this curve, although taken directly from the log data, is to show relative water movement downhole rather than absolute velocities as indicated by the specific values shown on the horizontal axis.

Interpretation of the Production Log is shown in Figure 6. This plot details zones of water entry, water loss and cumulative downhole water movement. These plots are highly interpretive and are subject to some quantitative arbitration. It does define, however, major zones of water entry and loss. Major production from the upper aquifer is between 260 and 630 feet, producing up to 500± gpm downhole. The lower aquifer lies between 1465 to 1480 feet and 1550 to 1580 feet (Figure 6).

The static water level for the upper aquifer is approximately 40± feet. The static water level for the combined aquifers is approximately 150-200 feet. The differential in head (pressure) between the two aquifers results in the net downhole recharge into the lower aquifer.

The zones of loss and production in the lower aquifer (1465 to 1580 feet) are interpretive. Theoretically, these zones cannot exist under these highly differing pressure conditions. However, these losses and gains do appear to exist on the Production Log and are therefore presented as such. Further pump tests and evaluation may provide additional data with which a better interpretation can be formulated.

SUMMARY AND CONCLUSIONS

Core Hole 6 was completed on July 23, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-6.

1. Static Water Levels
   - Upper Aquifer: 40± (G.L.)
   - Combined Aquifer: 200±
2. Maximum Production
   - Upper Aquifer: 375± gpm
   - Combined Aquifer: 575± gpm
3. Transmissivity
   - Upper Aquifer: 175 - 19,800 gpd/ft
   - Combined Aquifer: 365± gpd/ft

4. Specific Capacity

Upper Aquifer	0.50 gpm/ft
Combined Aquifer	0.24 gpm/ft

5. Water Quality

Upper Aquifer	- Specific Conductance	< 1500 micromhos
	- Temperature	57 - 66°F
	- pH	6.8 - 8.5
Combined Aquifer	- Specific Conductance	< 4000 micromhos
	- Temperature	62 - 81°F
	- pH	7.6 - 8.5

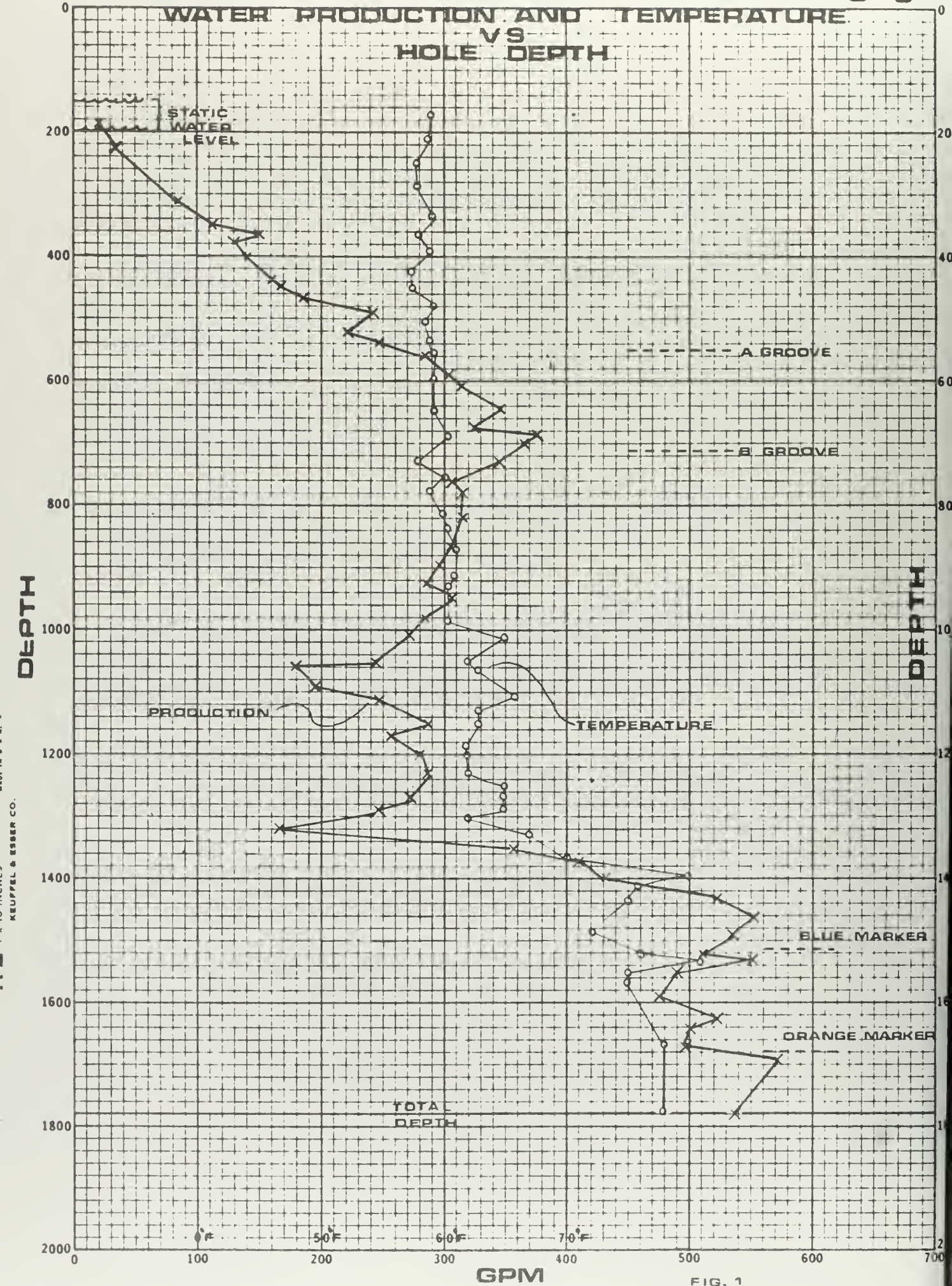
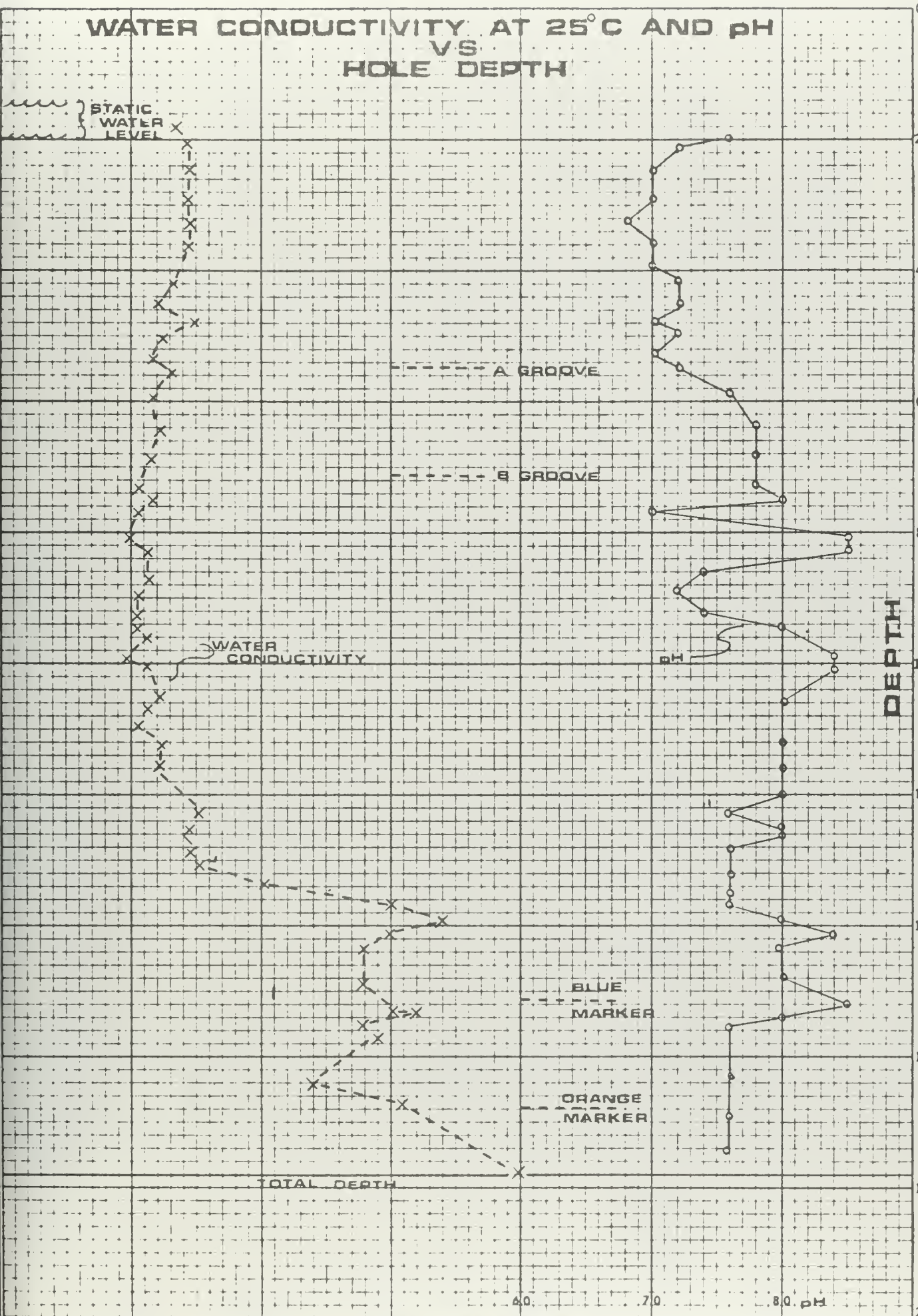
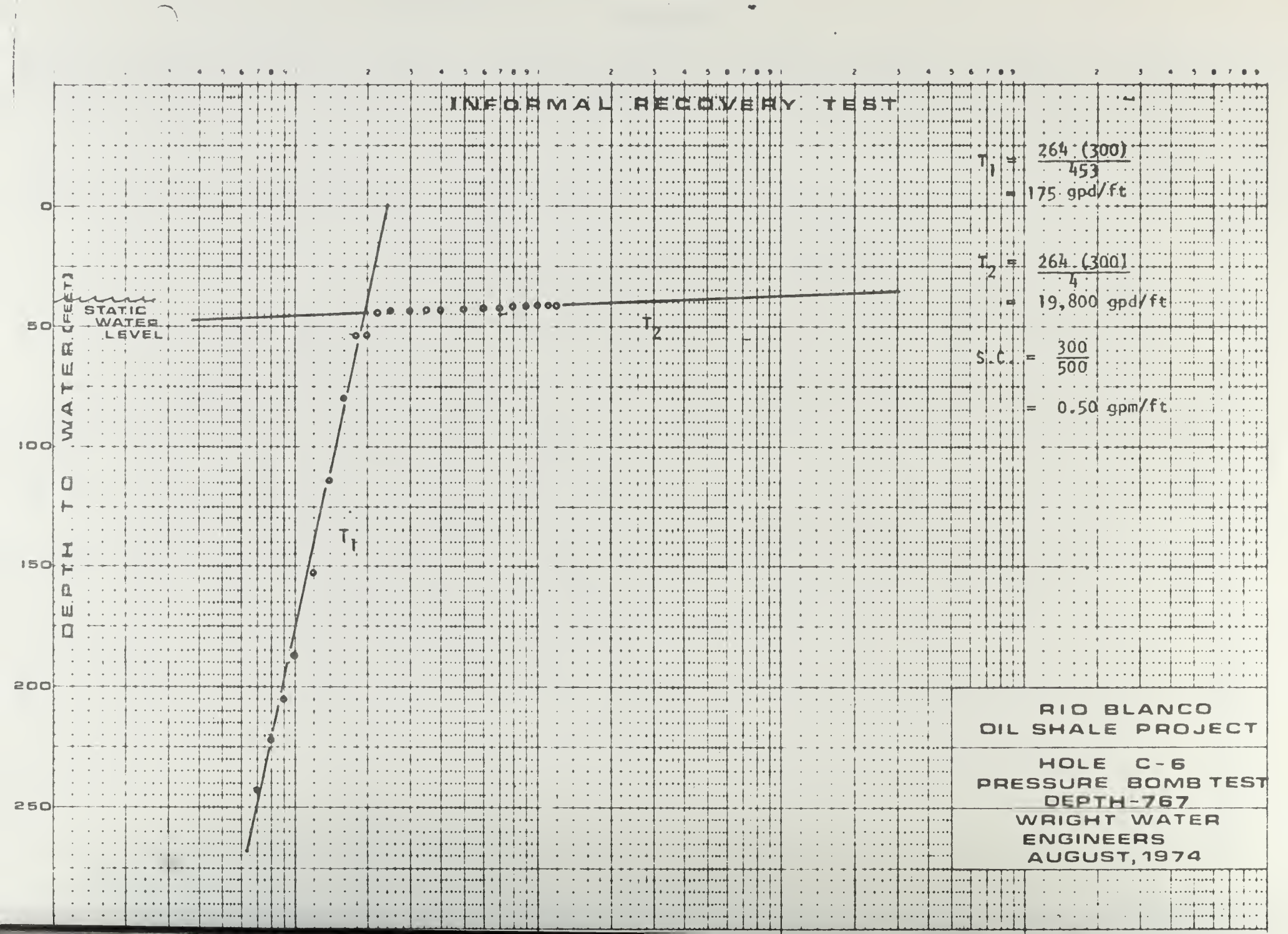
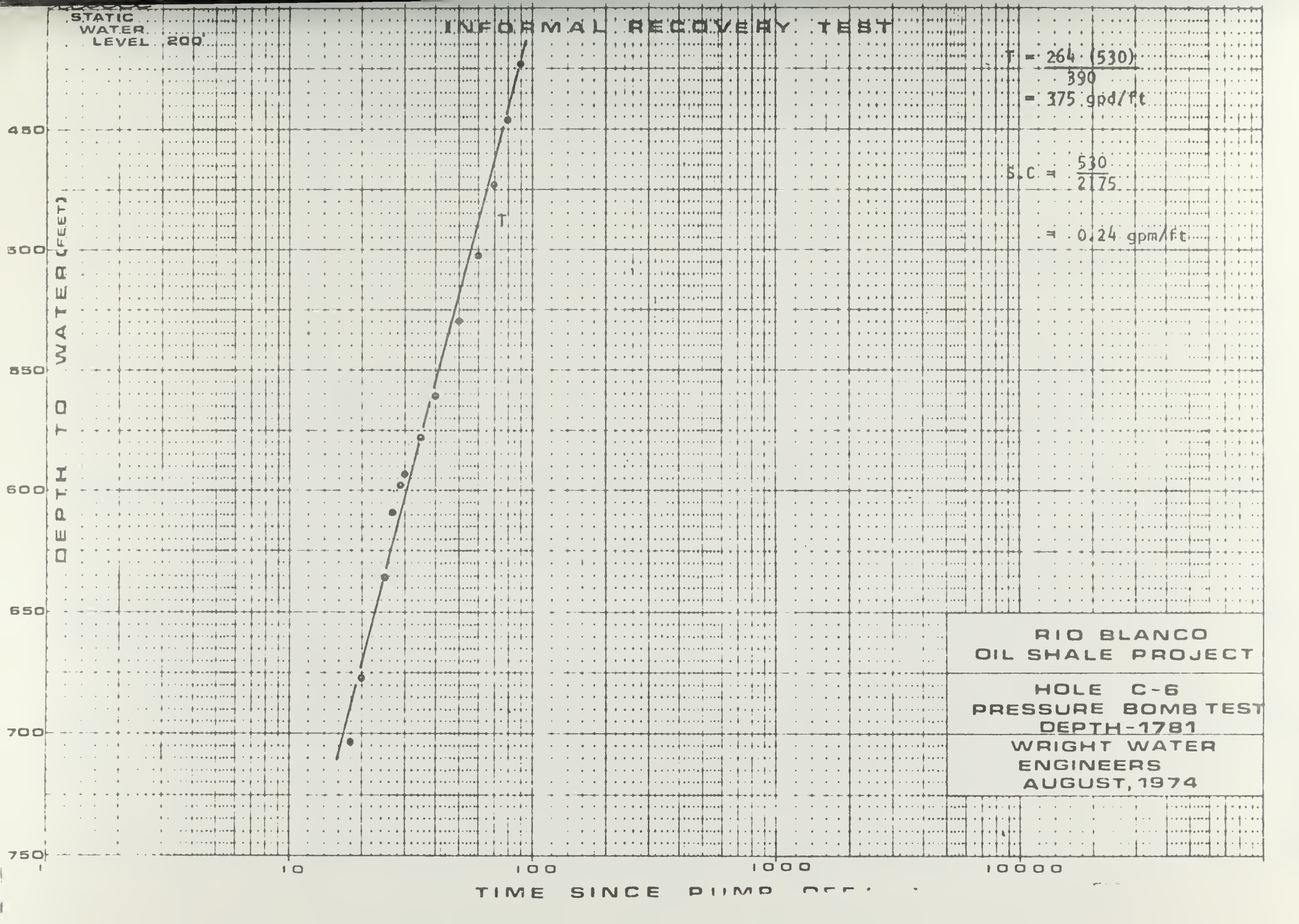

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
100
200
300
400
500
600
700
GPM
50°F
60°F
70°F

FIG. 1


WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
WATER CONDUCTIVITY
pH
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1000
2000
3000
4000
5000
6000
7000
6.0
7.0
8.0 pH


INFORMAL RECOVERY TEST
DEPTH TO WATER (FEET)
0
50
100
150
200
250
STATIC WATER LEVEL
T_1
T_2
$T_1 = \frac{264 \cdot (300)}{453}$
$= 175$ gpd/ft
$T_2 = \frac{264 \cdot (300)}{4}$
$= 19,800$ gpd/ft
$S.C. = \frac{300}{500}$
$= 0.50$ gpm/ft
RIO BLANCO
OIL SHALE PROJECT
HOLE C-6
PRESSURE BOMB TEST
DEPTH-767
WRIGHT WATER
ENGINEERS
AUGUST, 1974


STATIC WATER LEVEL 200'
INFORMAL RECOVERY TEST
T = 264 (530) / 390
= 375 gpd/ft
S.C = 530 / 2175
= 0.24 gpm/ft
T
DEPTH TO WATER (FEET)
450
500
550
600
650
700
750
10
100
1000
10000
TIME SINCE PUMP OFF
RIO BLANCO
OIL SHALE PROJECT
HOLE C-6
PRESSURE BOMB TEST
DEPTH-1781
WRIGHT WATER
ENGINEERS
AUGUST, 1974

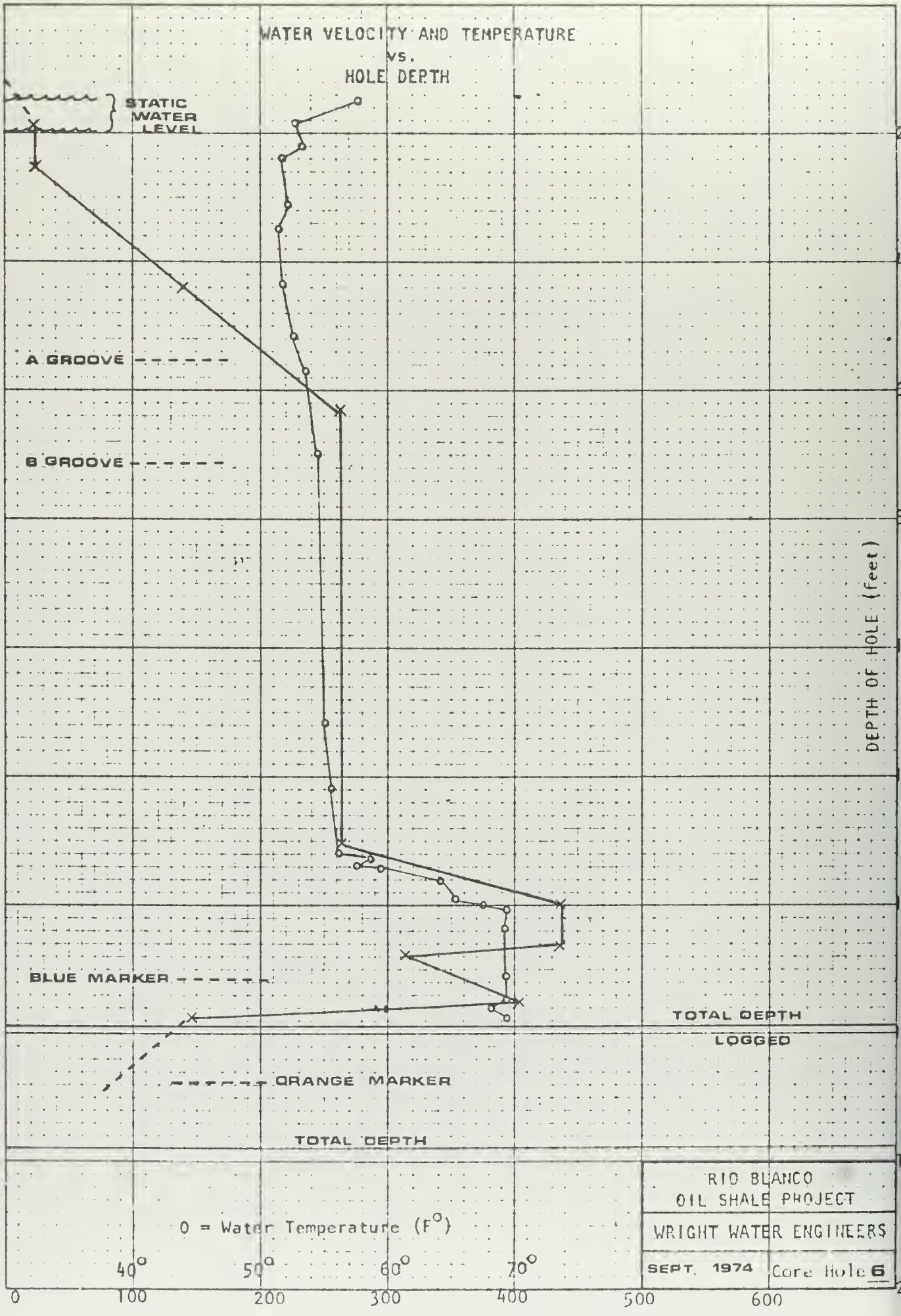


FIG. 5

KEUFFEL & ESSER CO

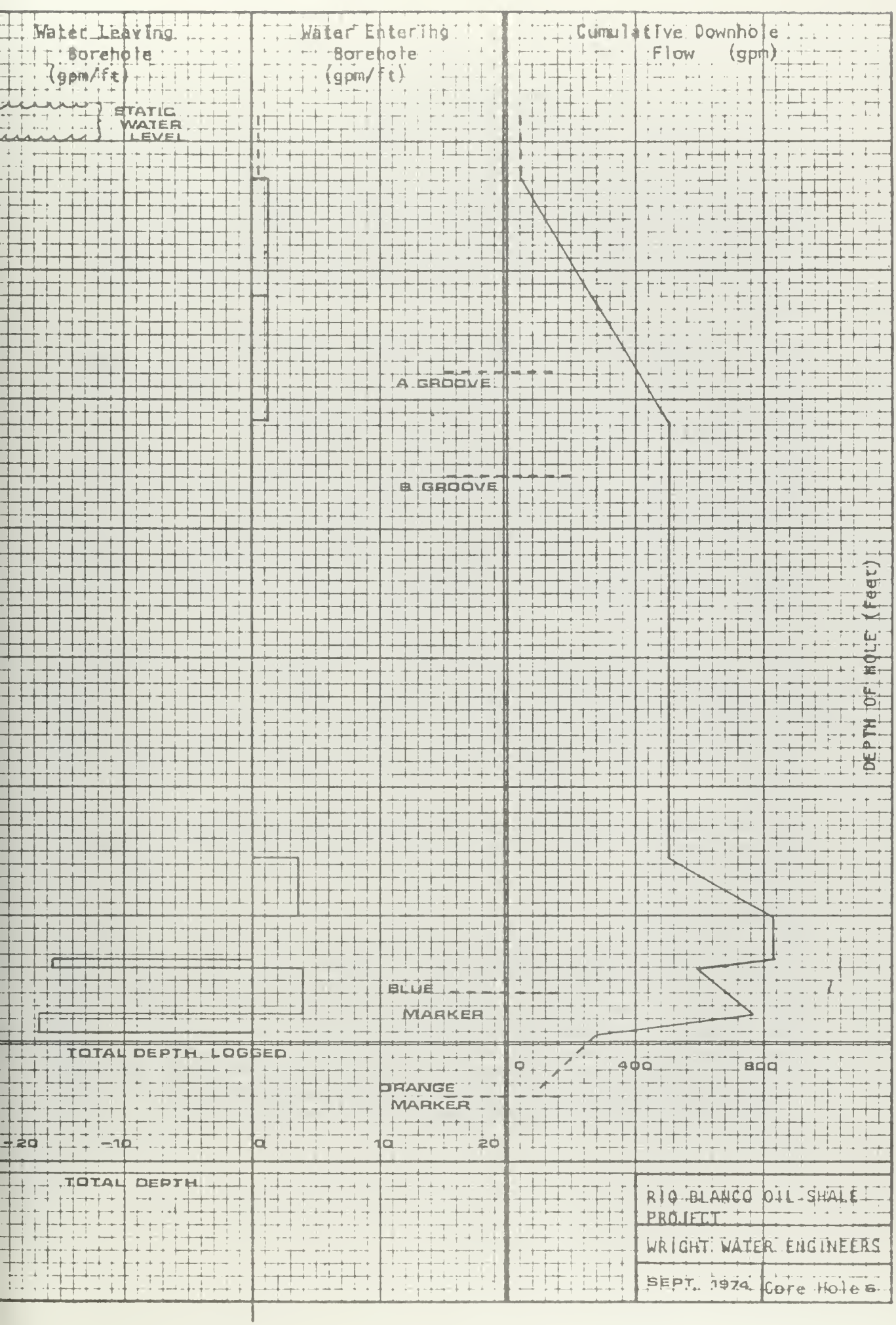

Water Leaving Borehole (gpm/ft)
Water Entering Borehole (gpm/ft)
Cumulative Downhole Flow (gpm)
STATIC WATER LEVEL
A GROOVE
B GROOVE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH LOGGED
TOTAL DEPTH
-20
-10
0
10
20
0
400
800
200
400
600
800
1000
1200
1400
1600
1800
2000
DEPTH OF HOLE (Feet)
RIO BLANCO OIL SHALE PROJECT
WRIGHT WATER ENGINEERS
SEPT. 1974 Core Hole 6

FIG. 6

CORE HOLE NO. 7
COMPLETION REPORT

Carmack Drilling Company of Grand Junction, Colorado, rigged up on location CH-7 (SE, NW, Sec. 5, T 2 S, R 99 W) on July 26, 1974. Drilling commenced and 154 feet of surface casing was set on that date. Coring began on July 27, 1974, with water production encountered at a depth of 200 ± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by the Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B groove" had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drill string. (See Figures 3 and 4)

The core hole was completed by landing and cementing casing, after Schlumberger Well Service Company ran a suite of geophysical logs on August 7, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenth of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-7 remained negligible until a depth of 200 ± feet had been reached, at which time production was 18 ± gallons per minute (gpm). Production increased gradually to 60 ± gpm at 345 feet, and remained stable to a depth of 555 feet. A gradual increase to 95 ± gpm occurred from 555 to 690 feet. Production then increased rapidly to 170 ± gpm at 800 feet, remained stable (150 ± - 180 ± gpm) to a depth of 945 feet, increased to 210 ± at 950 feet, and fluctuated between 200 and 250 gpm to total depth.

The lower aquifer was encountered between 690 and 700 feet.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals and tested at four intervals, and sent to The Industrial Laboratories Company of Denver for complete analysis: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove", and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

TABLE 1

WATER QUALITY CH-7

	Upper Aquifer (200' - 380')	Combined Aquifer (690' - 1200')
Conductivity (μmhos/cm @ 25°C)		
High	1100	1775
Average	1000 ±	1300 ±
Low	900	950
Temperature (°F.)		
High	62	72
Average	57	62
Low	53	56
pH		
High	7.2	7.1
Average	7.1	6.9
Low	6.9	6.4

The Industrial Laboratories Company analyzed the water samples which were collected, and submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low 53°F. to a high of 72°F.

Upper aquifer temperatures ranged from 53° to 62°F. to a depth of 690 ± feet. Combined aquifer water averaged 61° ± below 690 feet.

The pH records show a high reading of 7.2 and a low of 6.4. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 900 umhos/cm to a high of 1775 umhos/cm. The upper aquifer averaged approximately 1000 umhos/cm to 380 feet. The combined aquifer averaged approximately 1300 umhos/cm from 690 feet to total depth.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 261 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drill string. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS
CH-7

	Upper Aquifer	Combined Aquifer
Production	35 ± gal. per min.	240 ± gal. per min.
Static Water Level	<10 feet	390 ± feet
Transmissivity	40 - 770 gpd/ft.	320 - 1670 gpd/ft.
Specific Capacity	0.46 gpm/ft. of drawdown	1.1 gpm/ft. of drawdown

The first recovery test provides realistic estimates for all three aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. It also is rather anomalous in that the sharp break in slope indicates that a boundary effect is present in the vicinity of the well, adding to the rapid recovery. The second calculation of transmissivity (T_2 = gpd/ft.) therefore, is a more accurate indication of upper aquifer potential. The specific capacity (S.C. = 0.46 gpm/ft.) correlates with production and is also a realistic estimate.

The second recovery was conducted at total depth and provides realistic estimates of the combined aquifer characteristics. Like the first test, the second transmissivity (T_2= 1670 gpd/ft.) is more accurate, even though a stable static water level was not encountered prior to the end of the test.

PRODUCTION LOGGING

Schlumberger Well Service Company and Birdwell Well Service Company were to run two specialized logs for the purpose of measuring the temperature and downhole water movement in CH-7. Neither company was able to obtain the necessary tools to run these lugs within a reasonable amount of time; therefore, they were not completed.

Water movement in the hole is a downward flow, resulting from a higher static water level in the upper aquifer as compared to the lower aquifer. This differential in head (pressure) results in a net recharge from the upper to lower aquifers in an open borehole.

SUMMARY AND CONCLUSIONS

Core Hole 7 was completed on August 7, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-7.

1. Static Water Levels
   - Upper Aquifer: 10 ft. ± (G.L.)
   - Combined Aquifer: 240 ft. ± (G.L.)

2. Maximum Production
   - Upper Aquifer: 90 ± gpm
   - Combined Aquifer: 250 ± gpm

3. Transmissivity
   - Upper Aquifer: 40 - 770 gpd/ft.
   - Combined Aquifer: 320 - 1670 gpd/ft.

4. Specific Capacity
   - Upper Aquifer: 0.46 gpm/ft.
   - Combined Aquifer: 1.1 gpm/ft.

5. Water Quality

Upper Aquifer	- Specific Conductance	1100 micromhos
	- Temperature	53 - 62° F.
	- pH	6.9 - 7.2
Combined Aquifer	- Specific Conductance	1775 micromhos
	- Temperature	56 - 72° F.
	- pH	6.4 - 7.1

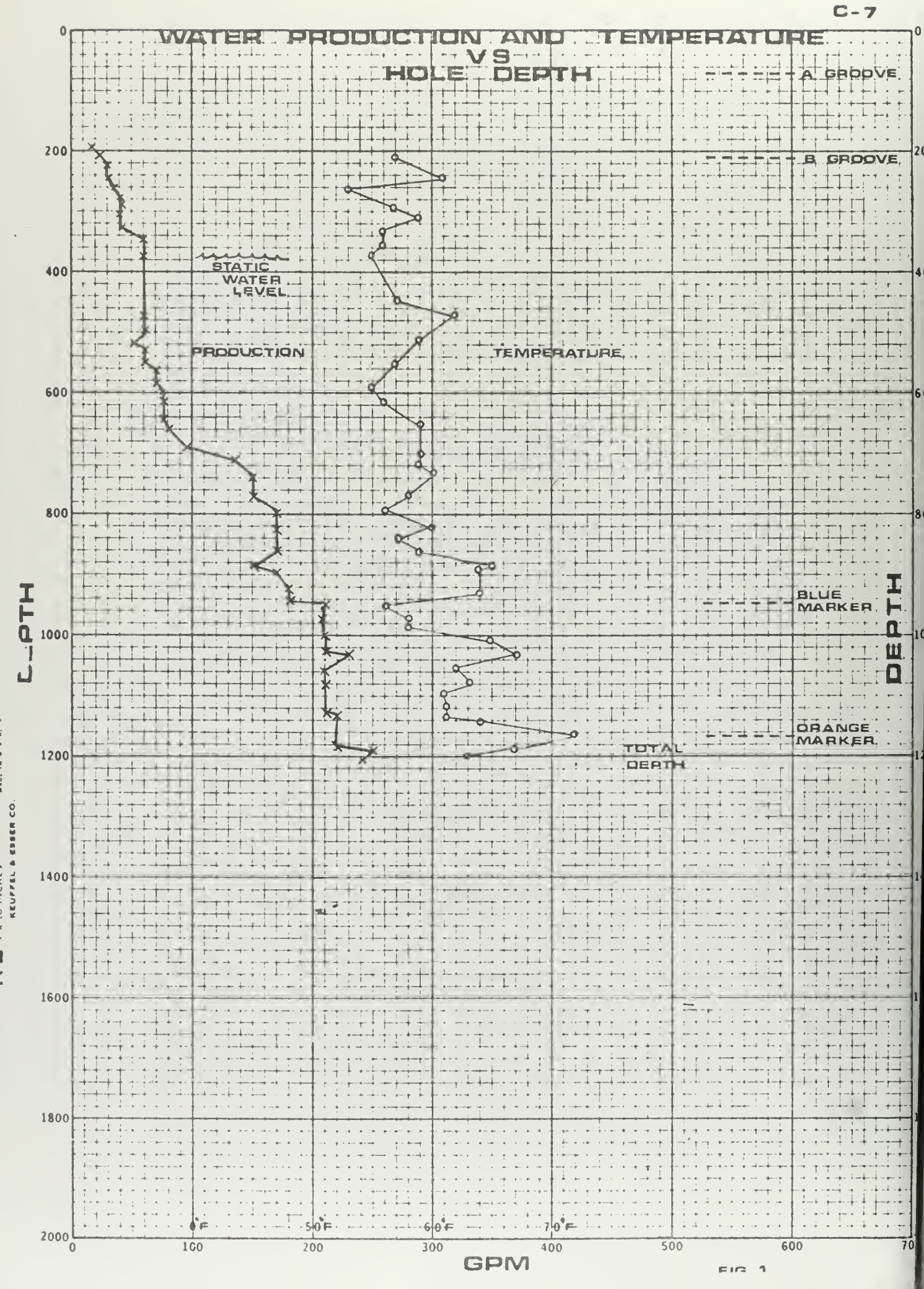

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
A GROOVE
B GROOVE
STATIC WATER LEVEL
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
100
200
300
400
500
600
50°F
60°F
70°F
GPM

FIG. 1

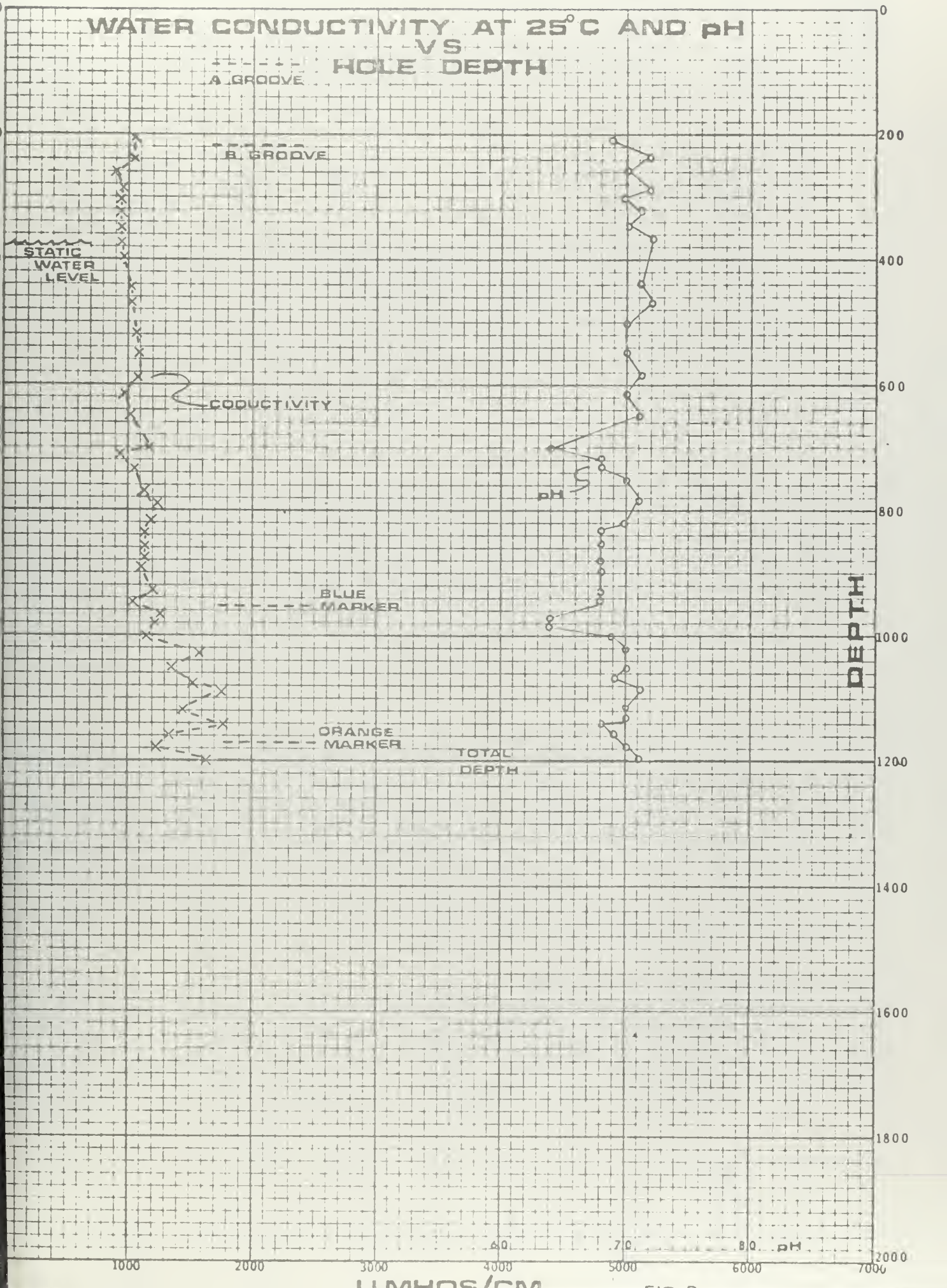
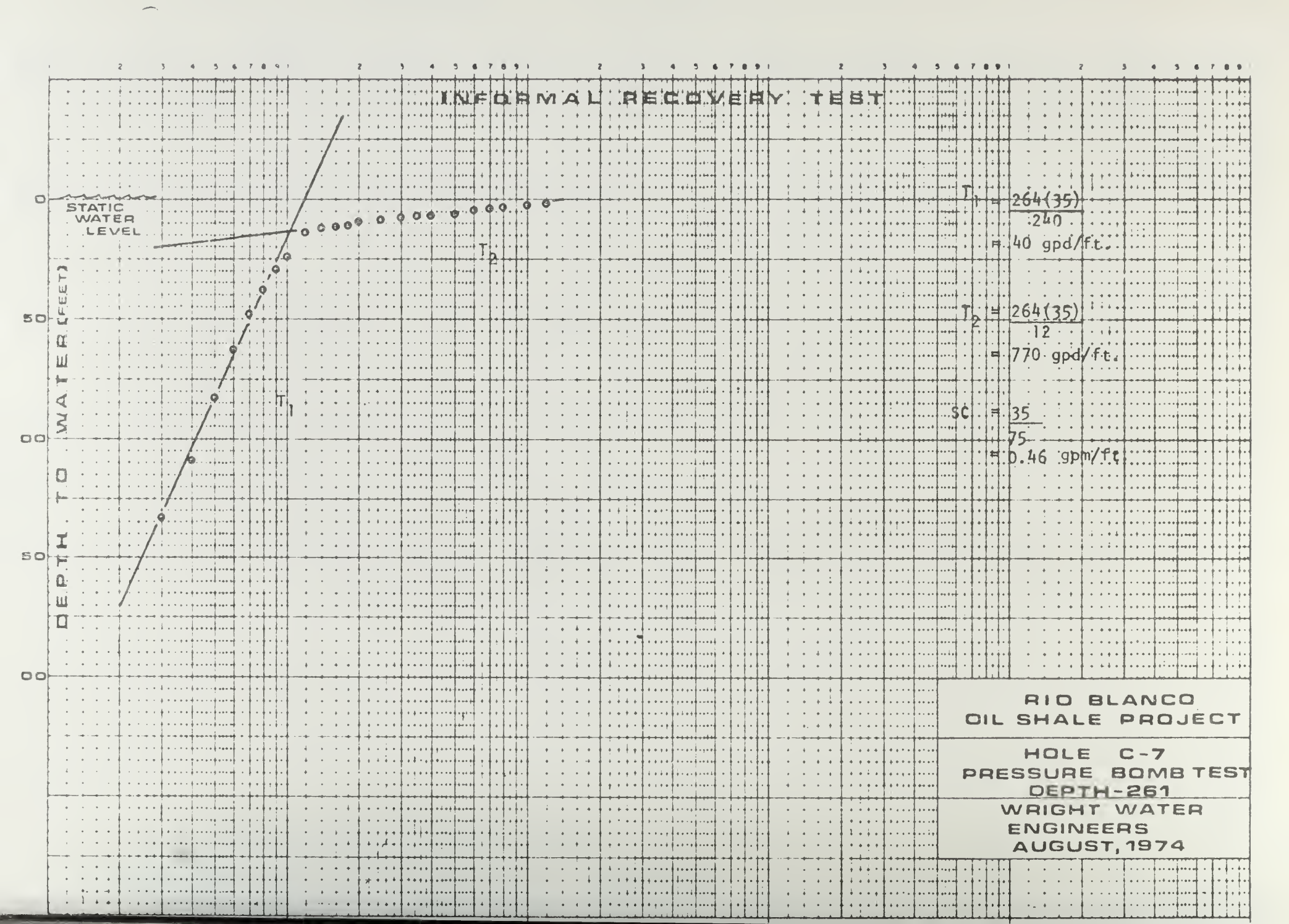

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
A GROOVE
B GROOVE
STATIC WATER LEVEL
CODUCTIVITY
pH
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
6.0
7.0
8.0
pH
1000
2000
3000
4000
5000
6000
7000
μ MHOS/CM

FIG. 2


INFORMAL RECOVERY TEST
STATIC WATER LEVEL
DEPTH TO WATER (FEET)
0
50
00
50
00
T_1
T_2
$T_1 = \frac{264(35)}{240}$
= 40 gpd/f.t.
$T_2 = \frac{264(35)}{12}$
= 770 gpd/f.t.
SC = $\frac{35}{75}$
= 0.46 gpm/f.t.
RIO BLANCO
OIL SHALE PROJECT
HOLE C-7
PRESSURE BOMB TEST
DEPTH-261
WRIGHT WATER
ENGINEERS
AUGUST, 1974

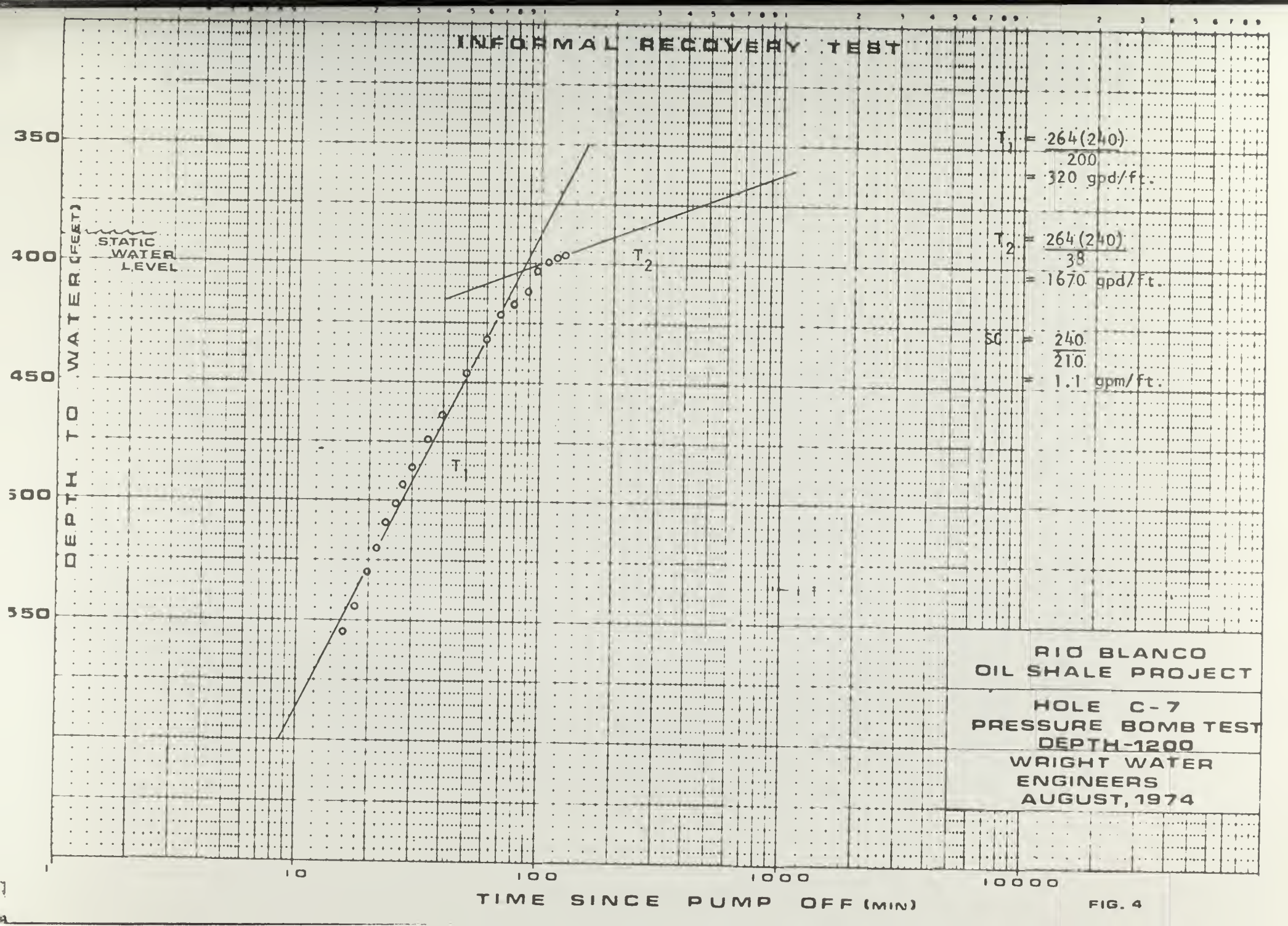

INFORMAL RECOVERY TEST
350
400
450
500
550
DEPTH TO WATER (FEET)
STATIC WATER LEVEL
T_1
T_2
$T_1 = \frac{264(240)}{200}$
$= 320$ gpd/ft.
$T_2 = \frac{264(240)}{38}$
$= 1670$ gpd/ft.
SC $= \frac{240}{210}$
$= 1.1$ gpm/ft.
RIO BLANCO
OIL SHALE PROJECT
HOLE C-7
PRESSURE BOMB TEST
DEPTH-1200
WRIGHT WATER
ENGINEERS
AUGUST, 1974
1
10
100
1000
10000
TIME SINCE PUMP OFF (MIN)

FIG. 4

CORE HOLE NO. 8 - COMPLETION REPORT

GENERAL

Carmack Drilling Company of Grand Junction, Colorado, rigged up on location CH-8(NE, SE, Sec. 5, T2S, R99W) on June 28, 1974. Drilling commenced on July 4, 1974, and reached total depth of 1616 feet on July 19, 1974.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: at first significant production, end of the "B groove" pump test, increase in production after "B groove," and at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling. After the "B groove" was penetrated, the water level recovery was measured with the use of an electrical wire-line tool. Upon reaching total depth, a similar test was run with the recovery data collected by a downhole pressure recorder set inside the drillstring (see Figure 3).

Casing was landed and cemented in on July 20, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Production remained negligible until a depth of 460± feet was reached. Production from that depth to 580± feet averaged 30 gallons per minute (gpm). From 580 feet to 660 feet production increased to 60± gpm. Between 660 feet and 1080 feet production averaged 65 gpm, increased to 170 gpm at 1200 feet and fluctuated from 120-185 gpm to 1530 feet. Near total depth production averaged 210 gpm.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals and tested for dissolved oxygen content and chlorine content. Samples were also collected at four intervals, and sent to The Industrial Laboratories Company of Denver, for complete analysis: at first significant production, during "B groove" pump test, significant increase below "B groove," and at total depth. Table I below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 56° F. to a high of 68° F. (an anomalous reading of 75° F. was recorded at 305 feet which represents drilling water injected into the borehole).

Upper aquifer temperatures averaged 59°-60° F. to a depth of 1180± feet. Combined aquifer water averaged 64±° F. below 1180 feet, with a distinct increase at the top of the lower aquifer (1180 feet).

The pH records show a high reading of 8.5 (reflecting drilling fluid) and a low of 6.2. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings (see Figure 2) give values ranging from a low of 984 umhos/cm to a high of 3540 umhos/cm. The upper aquifer averaged approximately 1100 umhos/cm to 720 feet. The combined aquifer averaged approximately 2250 umhos/cm from 1175 feet to total depth.

TABLE I

WATER QUALITY CH-8

	Upper Aquifer (460'- 720')	Lower Aquifer (1150'-1600')
Conductivity (umhos/cm @ 25°C)		
High	1263	3540
Average	1100±	2250
Low	984	1428
Temperature (°F.)		
High	63	68
Average	59	64±
Low	56	56
pH		
High	8.0	8.0
Average	7.0	7.5
Low	6.2	6.8

Industrial Laboratories Company analyzed the water samples which were collected, and submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 664 feet. The second was conducted at total depth.

The first test consisted of two hours of continuous airlift pumpage, after which an electric probe was lowered into the open-ended drillstring to measure water level increases. This test yielded limited results in that the water had fully recovered before the first reading could be obtained. This test yielded a static water level of 345 feet.

The second test utilized the same basic technique for pumpage (airlift for a minimum of two hours) but results were obtained with a down-hole pressure recorder. Included is the analysis of the pressure bomb recording and plot thereof (Figure 3). This plot enables one to calculate the approximate transmissivity, static water level, and specific capacity of the combined aquifers. Table 2 below summarizes the results of these tests.

TABLE 2

INFORMAL PUMP TESTS CH-8

	Upper Aquifer	Combined Aquifers
Production	90 gallons per minute	210 gallons per minute
Static Water Level	345 feet	520± feet
Transmissivity	Insufficient data	400-1200 gallons per day per foot
Specific Capacity	Insufficient data	0.84 gallons per minute per foot of drawdown

PRODUCTION LOGGING

Schlumberger Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the borehole. The Temperature Log data are plotted on Figure 4. The Engineered Production Log, which measures the velocity of nonpumping water in the borehole, is also plotted on Figure 4. The value of this curve, although taken directly from the log data, is to show relative water movement downhole rather than absolute velocities as indicated by the specific values shown on the horizontal axis.

Interpretation of the Production Log is shown in Figure 5. This plot details zones of water entry, water loss and cumulative downhole water movement. These plots are highly interpretive and are subject to some quantitative arbitration. It does define, however, major zones of water entry and loss. Major production from the upper aquifer is between 460 and 720 feet, producing up to 300± gpm downhole. The lower aquifer lies between 720 feet and total depth, with major fracturing occurring between 1060 and 1410 feet (Figure 5).

The static water level for the upper aquifer is approximately 345 feet. The static water level for the combined aquifers is approximately 520 feet. This differential in head (pressure) results in the net downhole recharge into the lower aquifer.

SUMMARY AND CONCLUSIONS

Core Hole 8 was completed on July 20, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-8.

1. Static Water Levels
   - Upper Aquifer: 345'± (G.L.)
   - Combined Aquifer: 520'± (G.L.)

2. Maximum Production
   - Upper Aquifer: 100± gpm
   - Combined Aquifer: < 250 gpm

3. Transmissivity
   - Upper Aquifer: Insufficient data
   - Combined Aquifer: 400-1200 gpd/ft.

4. Specific Capacity
   - Upper Aquifer: Insufficient data
   - Combined Aquifer: 0.84 gpm/ft.

5. Water Quality
   - Upper Aquifer - Specific Conductance: < 1263 micromhos
     - Temperature: 56° - 63°F
     - pH: 6.2 - 8.0
   - Combined Aquifer - Specific Conductance: < 3540 micromhos
     - Temperature: 56° - 68°F
     - pH: 6.8 - 8.0

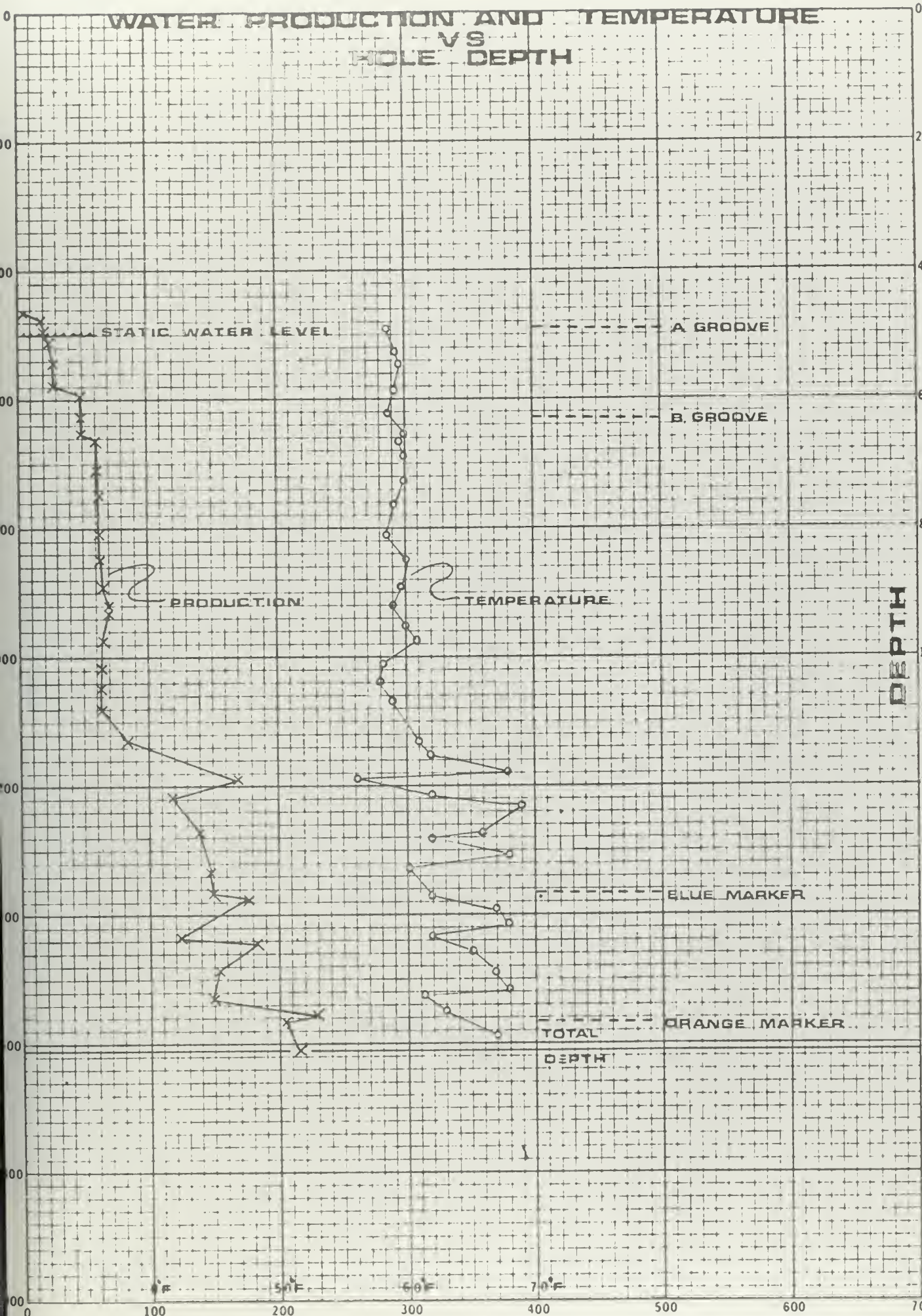
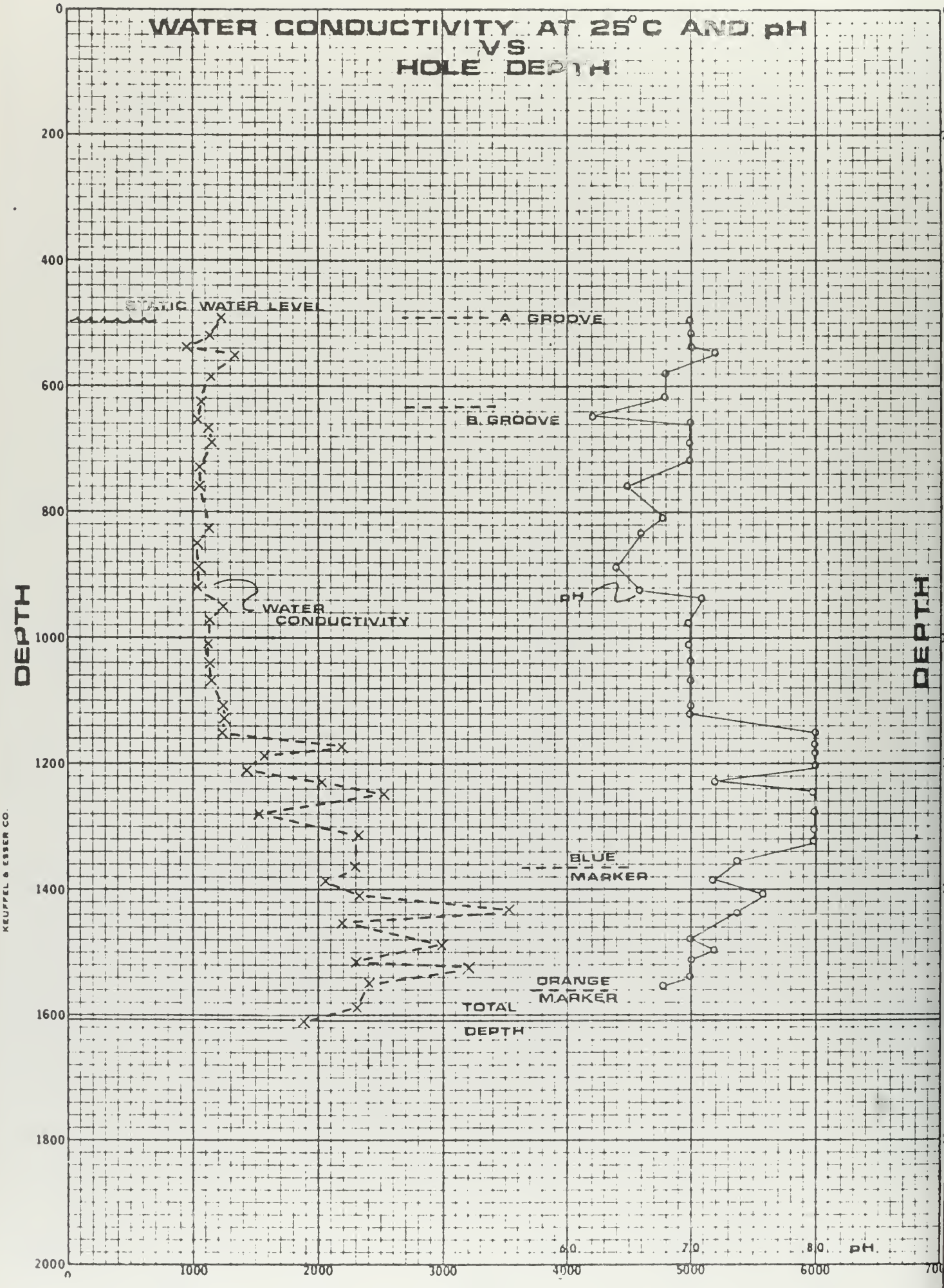

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL
DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50°F
60°F
70°F
0
100
200
300
400
500
600
700
GPM

FIG. 1



7 X 10 INCHES
KEUFFEL & ESSER CO.

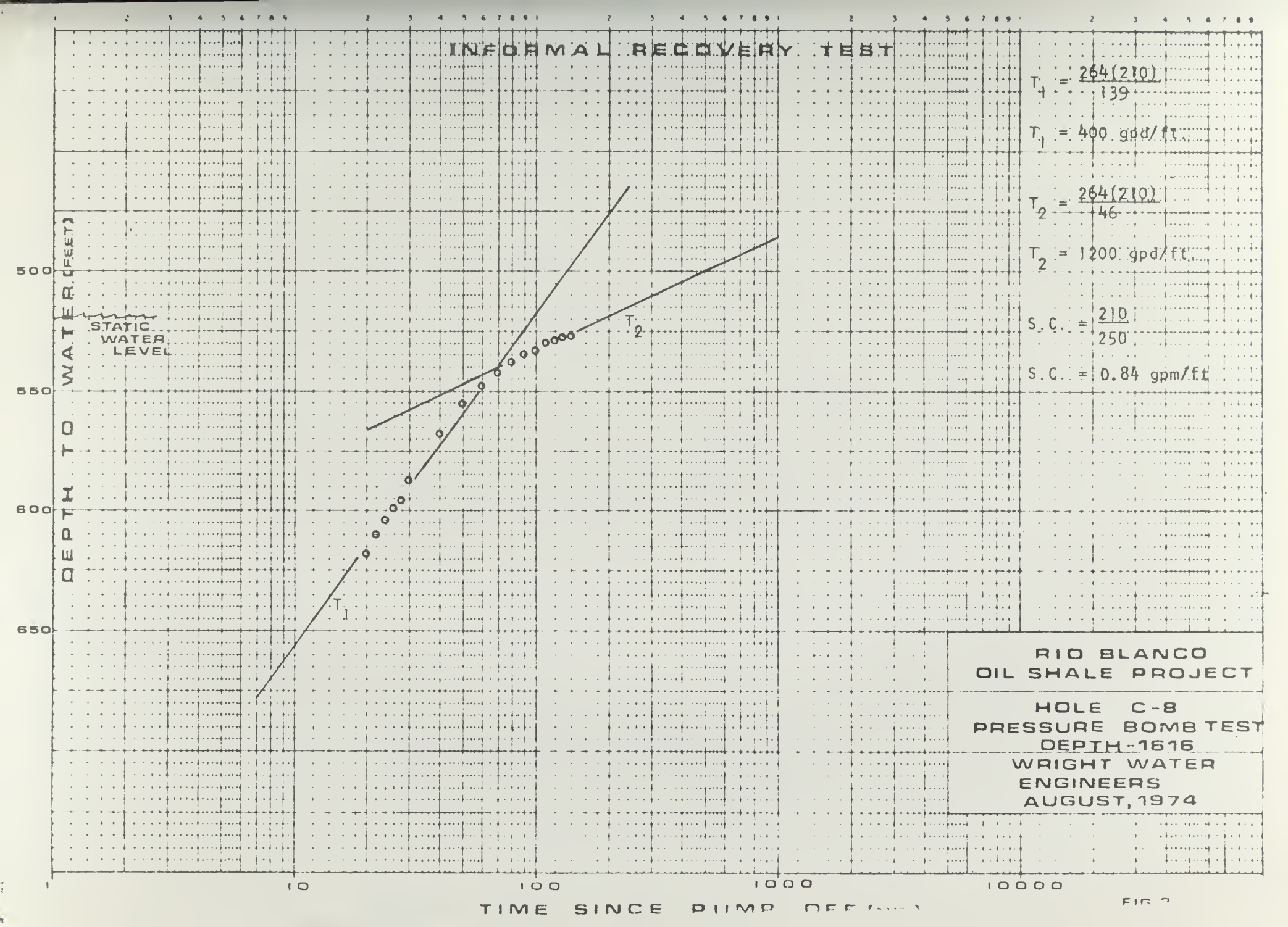
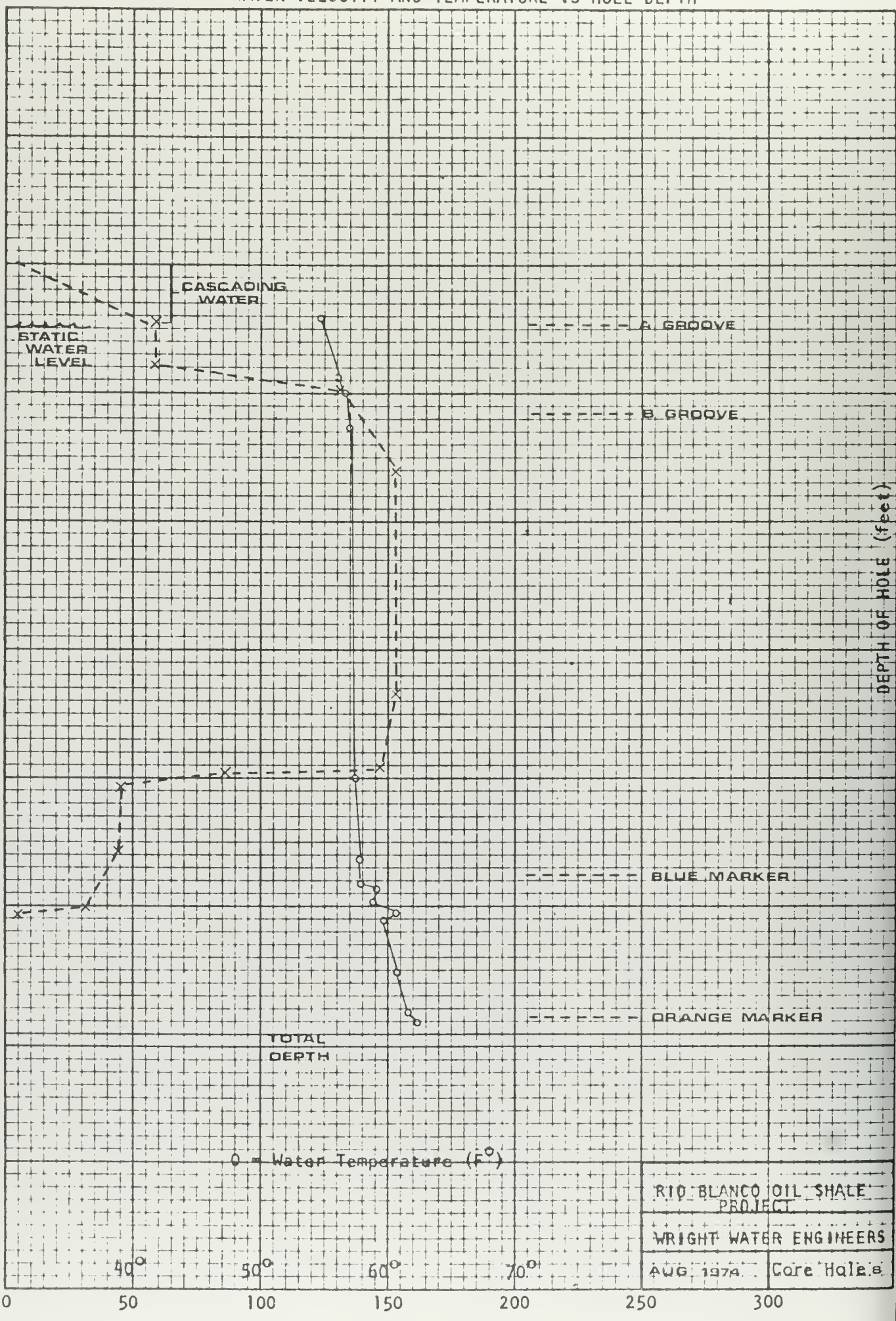

INFORMAL RECOVERY TEST
$T_1 = \frac{264(210)}{139}$
T_1 = 400 gpd/ft.
$T_2 = \frac{264(210)}{46}$
T_2 = 1200 gpd/ft.
S.C. = $\frac{210}{250}$
S.C. = 0.84 gpm/ft.
DEPTH TO WATER (FEET)
500
550
600
650
STATIC WATER LEVEL
T_1
T_2
1
10
100
1000
10000
TIME SINCE PUMP OFF
RIO BLANCO
OIL SHALE PROJECT
HOLE C-8
PRESSURE BOMB TEST
DEPTH-1616
WRIGHT WATER
ENGINEERS
AUGUST, 1974

FIG 2

WATER VELOCITY AND TEMPERATURE VS HOLE DEPTH



RIO BLANCO OIL SHALE PROJECT

WRIGHT WATER ENGINEERS

AUG. 1974 | Core Hole 8

KE&E 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

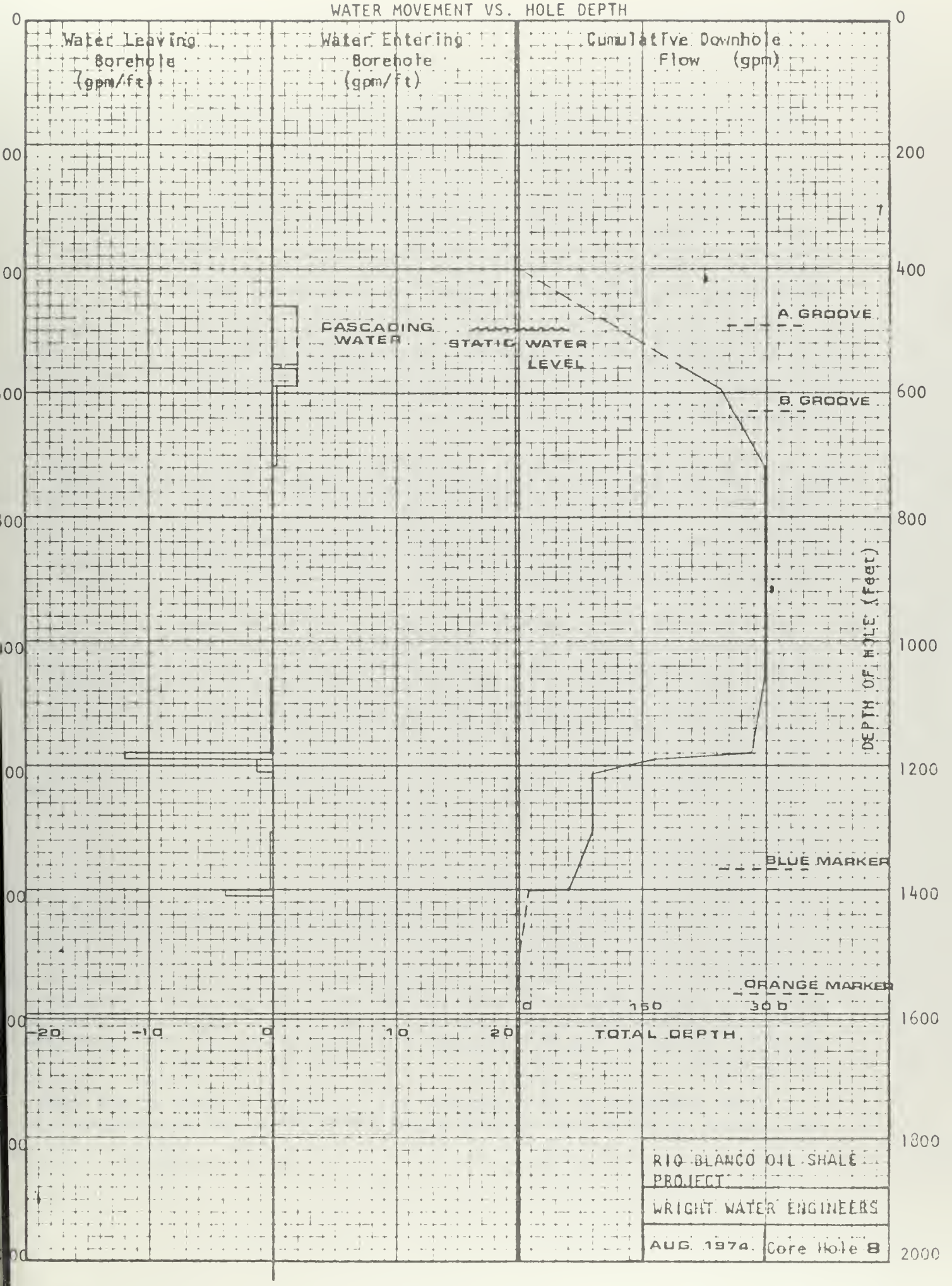

WATER MOVEMENT VS. HOLE DEPTH
Water Leaving Borehole (gpm/ft)
Water Entering Borehole (gpm/ft)
Cumulative Downhole Flow (gpm)
CASCADING WATER
STATIC WATER LEVEL
A GROOVE
B GROOVE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH OF HOLE (Feet)
-20
-10
0
10
20
0
150
300
0
200
400
600
800
1000
1200
1400
1600
1800
2000
RIO BLANCO OIL SHALE PROJECT
WRIGHT WATER ENGINEERS
AUG. 1974
Core Hole 8

FIG. 5

CORE HOLE NO. 9
COMPLETION REPORT

Dreiling Drilling Company of Denver, Colorado, rigged up on location CH-9 (SE, NW, Sec. 4, T1S, R99W) on August 28, 1974. Drilling commenced and 156 feet of surface casing was set the following day. Coring began on August 31, 1974 with significant water production encountered at a depth of 300± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed at the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot intervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B groove" had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process), discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figures 3 and 4).

The corehole was completed by landing and cementing casing, after Birdwell Well Service Company ran a suite of geophysical logs on September 12, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and stilling well adapted with a Stevens Type F recorder. These are mounted at the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the stilling well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water production and temperature versus depth.

Water production on CH-9 remained negligible until a depth of 300± feet was reached, at which time the well produced 20± gallons per minute (gpm).

Production increased to 70± gpm at 440 feet, stabilized to 575± feet, and increased to 125 gpm at 690 feet. Production remained relatively stable (125 - 140 gpm) to a depth of 1100 feet, where the second aquifer was encountered. A rapid increase to 250 gpm at 1230 feet, and a gradual increase to a maximum production of 300 gpm at 1560 feet were encountered in the lower aquifer.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals. Samples were also collected at four intervals, and sent to The Industrial Laboratories Company of Denver, for complete analysis: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove" and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperatures variations of the water produced during drilling. These ranged from a low of 54°F to a high of 75°F.

Upper aquifer temperatures ranged from 54°F to 63°F to a depth of 1080± feet. Combined aquifer water averaged 69°F below 1080 feet, with a distinct increase at the top of the lower aquifer (1080± feet).

The pH records show a high reading of 8.0 and a low of 6.4. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 1408 μmhos/cm to a high of 3560 umhos/cm. The upper aquifer averaged approximately 1520 μmhos/cm to 630 feet. The combined aquifer averaged approximately 2600 μmhos/cm from 1080 feet to total depth.

TBALE 1

WATER QUALITY CH-9

	Upper Aquifer (300' - 630')	Lower Aquifer (1080' - 1600')
Conductivity (μmhos/cm @ 25°C)		
High	1653	3560
Average	1520±	2600±
Low	1408	1660
Temperature (°F.)		
High	63	75
Average	58	69
Low	54	61
pH		
High	7.0	8.0
Average	6.7	7.4
Low	6.4	7.0

The Industrial Laboratories Company analyzed the water samples which were collected, and have submitted detailed qualitative results. Copies are not included herein, but are available if a review necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 651 feet. The second was conducted at total depth. Each pump tests consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2

INFORMAL PUMP TESTS
CH-9

	Upper Aquifer	Combined Aquifer
Production	100± gpm	300± gpm
Static Water Level	320± feet	370± (from E-Logs)
Transmissivity	(Insufficient Data)	240 - 1200 gpd/ft
Specific Capacity	0.5 gpm/ft of drawdown	0.63 gpm/ft of drawdown

The first recovery test does not provide sufficient data to permit calculations of the transmissivity. The recovery rate was too rapid to allow the pressure bomb to be set in the hole prior to the water reaching static level. The static water level is 320± feet, and the estimate of specific capacity (S.C. = 0.5) does seem realistic.

The second recovery test provides realistic estimates for all three aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. The second calculation of transmissivity (T_2 = 1200 gpd/ft) therefore, is a more accurate indication of combined aquifer potential. The specific capacity (S.C. = 0.63 gpm/ft) correlates with production and is also a realistic estimate.

PRODUCTION LOGGING

Birdwell Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the bore hole. The Temperature Log data are plotted on Figure 5. The Spinner Production Log, which measures the velocity of nonpumping water in the bore hole has not been completely evaluated at this time. It does, however, show that the water movement in the bore hole is downward, thus recharging from the upper to lower aquifer.

Preliminary interpretation of the Production Log indicates major zones of water entry occur in the upper aquifer between 360 and 710 feet. The lower aquifer lies between 1070 and 1600 feet, the interval in which water loss is taking place.

The static water level for the upper aquifer is approximately $320\pm$ feet. The static water level for the combined aquifers is approximately $370\pm$ feet. The differential in head (pressure) between the two aquifers results in the net downhole recharge into the lower aquifer.

SUMMARY AND CONCLUSIONS

Core Hole 9 was completed on September 12, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which appear to be valid for the hydrology of CH-9.

1. Static Water Levels
   - Upper Aquifer: $320\pm$ (G.L.)
   - Combined Aquifer: $370\pm$ (G.L.) (from E-Logs)

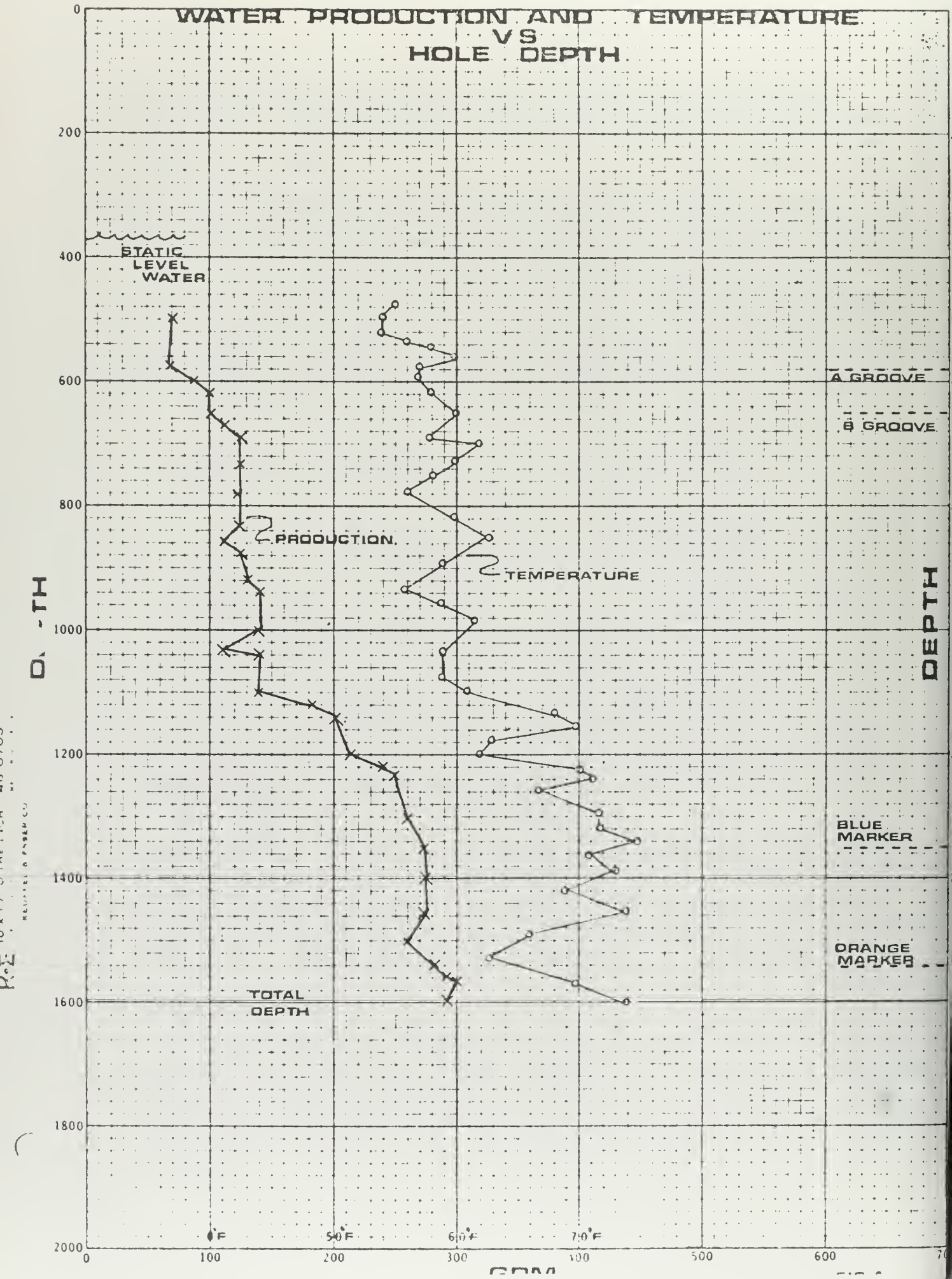
2. Maximum Production
   - Upper Aquifer: $125\pm$ gpm
   - Combined Aquifer: $300\pm$ gpm

3. Transmissivity
   - Upper Aquifer: (Insufficient Data)
   - Combined Aquifer: 240 - 1200 gpd/ft

4. Specific Capacity
   - Upper Aquifer: 0.5 gpm/ft
   - Combined Aquifer: 0.63 gpm/ft

5. Water Quality

Upper Aquifer	- Specific Conductance	$<$1653 micromhos
	- Temperature	54 - 63°F
	- pH	6.4 - 7.0
Combined Aquifer	- Specific Conductance	$<$3560 micromhos
	- Temperature	61 - 75°F
	- pH	7.0 - 8.0


WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC LEVEL WATER
PRODUCTION
TEMPERATURE
A GROOVE
B GROOVE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50°F
60°F
70°F
100
200
300
400
500
600
GPM

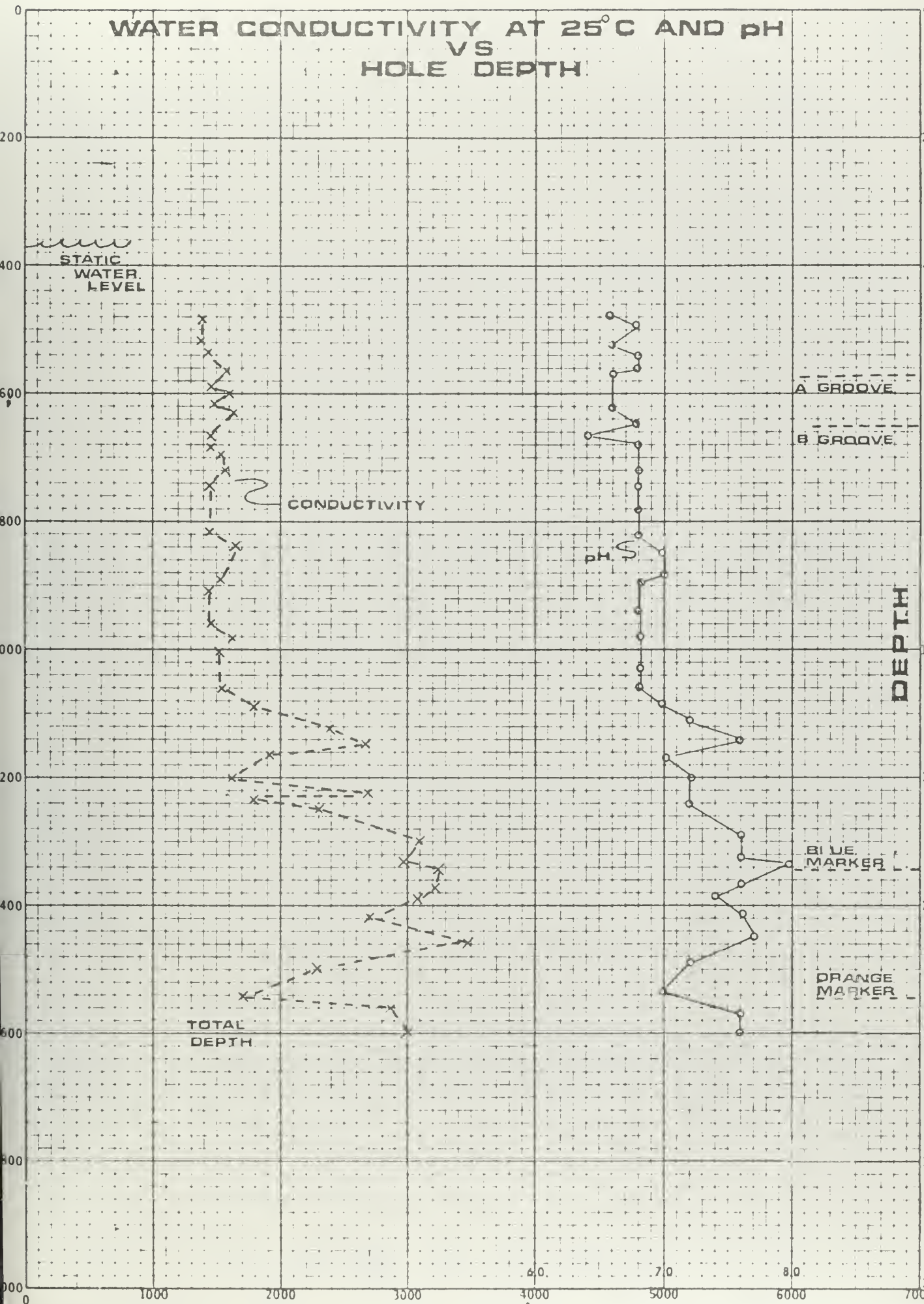
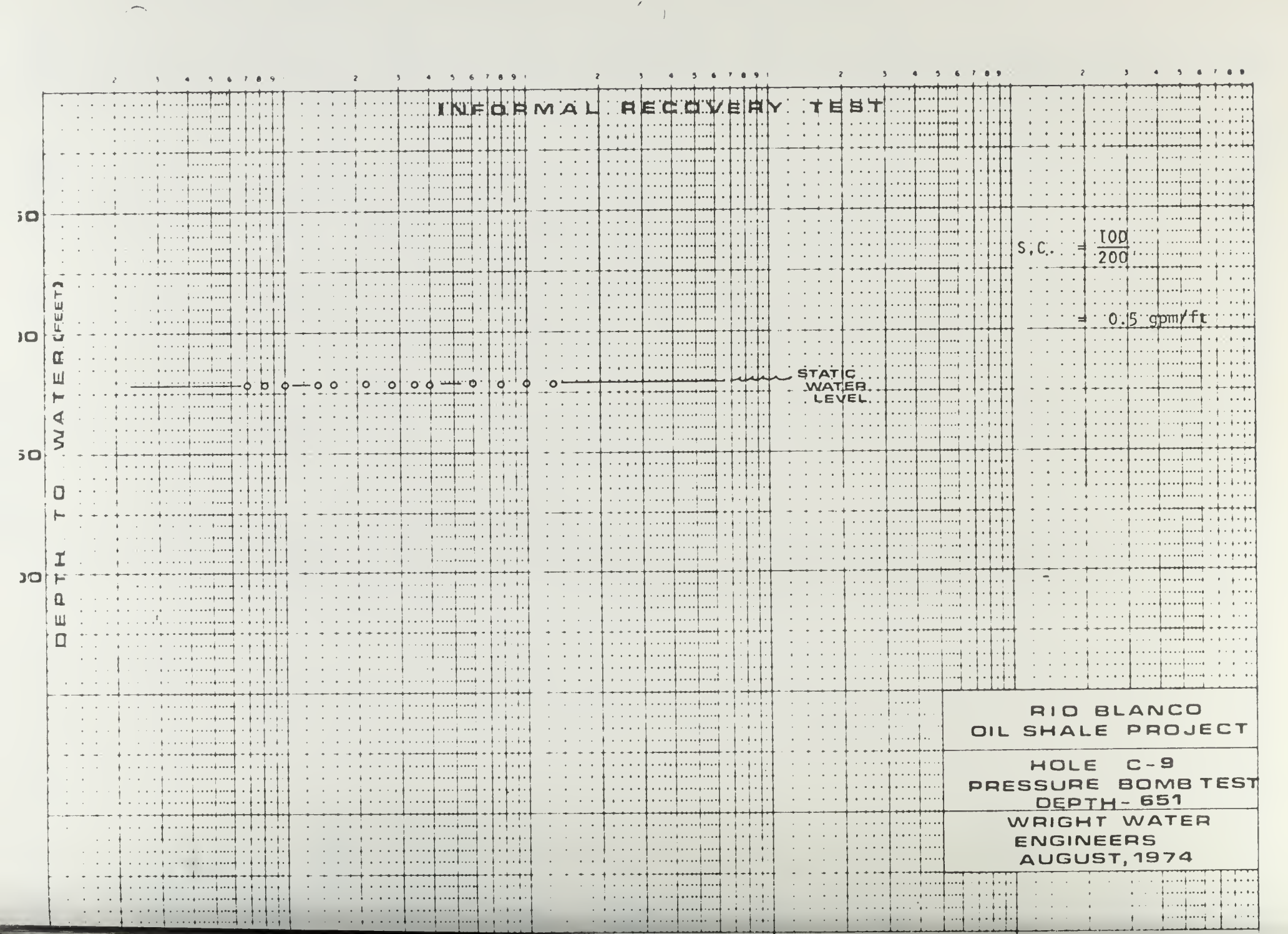

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
CONDUCTIVITY
pH
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
6.0
7.0
8.0
1000
2000
3000
4000
5000
6000
7000
μ MHOS/CM

FIG. 2


INFORMAL RECOVERY TEST
DEPTH TO WATER (FEET)
STATIC WATER LEVEL
S.C. = 100/200
= 0.5 gpm/ft
RIO BLANCO OIL SHALE PROJECT
HOLE C-9
PRESSURE BOMB TEST
DEPTH - 651
WRIGHT WATER ENGINEERS
AUGUST, 1974

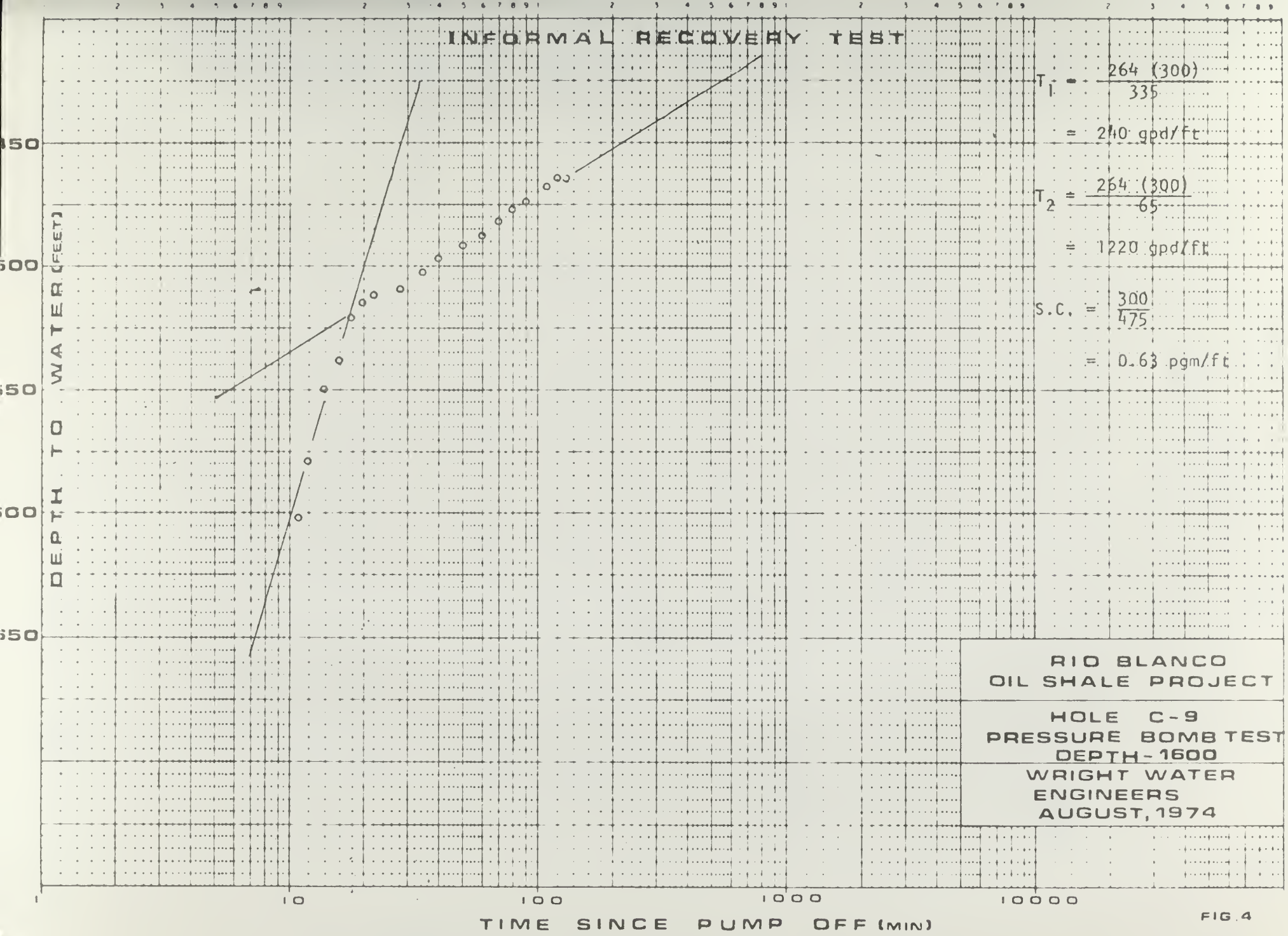
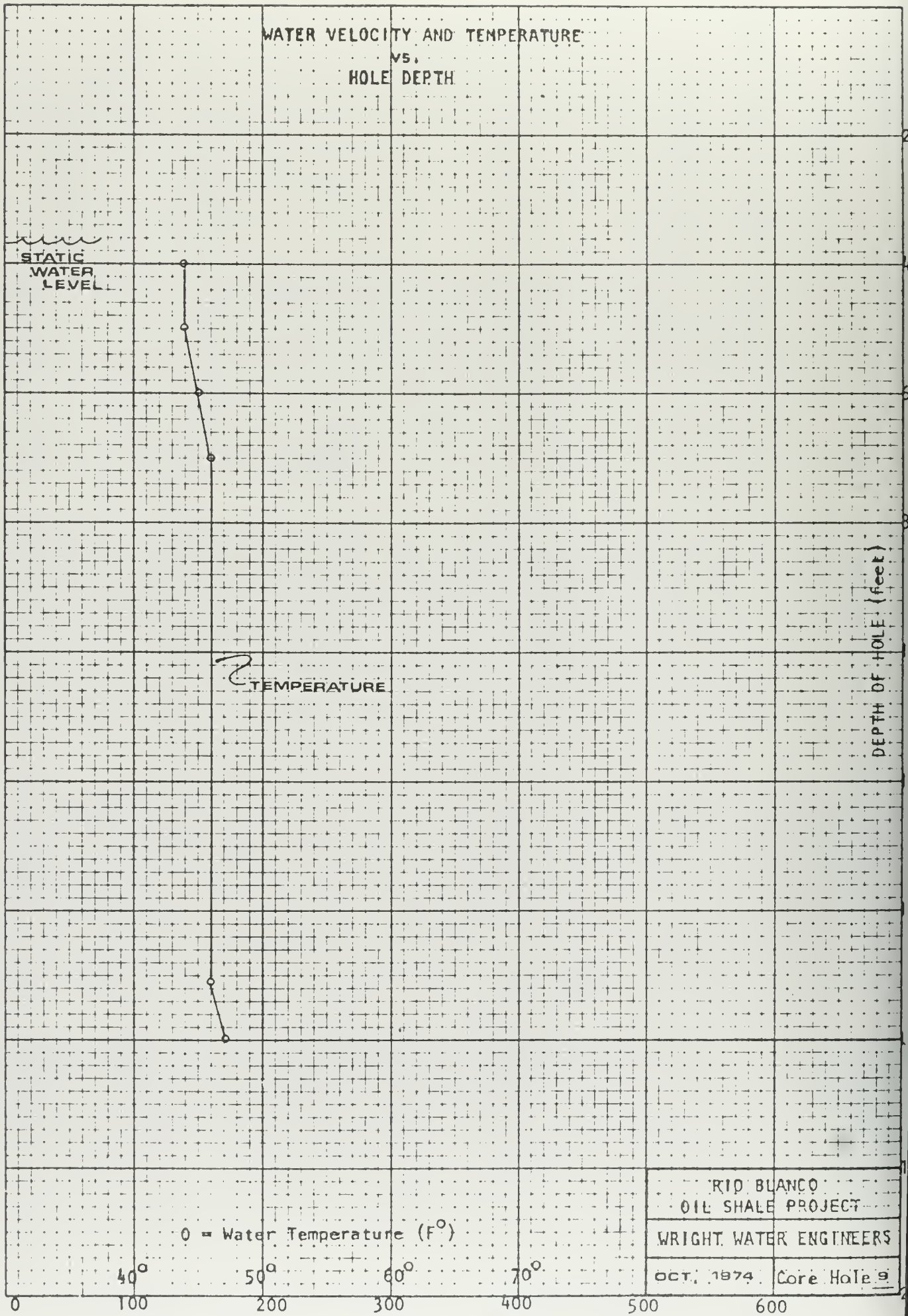

INFORMAL RECOVERY TEST
$T_1 = \frac{264\ (300)}{335}$
= 240 gpd/ft
$T_2 = \frac{264\ (300)}{65}$
= 1220 gpd/ft
S.C. = $\frac{300}{475}$
= 0.63 pgm/ft
RIO BLANCO
OIL SHALE PROJECT
HOLE C-9
PRESSURE BOMB TEST
DEPTH - 1600
WRIGHT WATER
ENGINEERS
AUGUST, 1974
DEPTH TO WATER (FEET)
TIME SINCE PUMP OFF (MIN)
1
10
100
1000
10000

FIG. 4



7 X 10 INCHES
KEUFFEL & ESSER CO.
MADE IN U.S.A.

CORE HOLE NO. 12
COMPLETION REPORT

Carmack Drilling Company of Grand Junction, Colorado, rigged up on location CH-12 (NE, SW, Sec. 9, T2S, R99W) on September 3, 1974. Drilling commenced and 161 feet of surface casing was set on September 5, 1974. Coring began on September 6, 1974 with significant water production encountered at a depth of 630± feet, at which time hydrologic data collection commenced.

Hydrologic data were collected in two basic categories: water production and water quality. Water production was monitored throughout drilling by means of a Parshall flume installed as the outlet in the blooey pit. The water levels in the flume were measured by an automatic recording float device, a Stevens Type F unit.

Water quality was tested at approximately thirty-foot invervals by measuring conductivity, pH and temperature. In addition, a set of samples was collected at each of four intervals during drilling: 1) at first significant production, 2) end of the "B groove" pump test, 3) increase in production after "B groove", and 4) at total depth. These samples were analyzed by The Industrial Laboratories Company of Denver through both standard wet chemical and spectrographic methods.

To evaluate the potential of the aquifer systems, informal pump tests were conducted twice during drilling: after the "B groove" had been penetrated and after reaching total depth. These consisted of two hours of continuous airlift pumpage (during the coring process) discontinuing the pumping, and the recording of water level increases by a downhole pressure recorder set inside the drillstring (See Figures 3 and 4).

The core hole was completed by landing and cementing casing, after Birdwell Well Service Company ran a suite of geophysical logs on September 15, 1974.

WATER PRODUCTION

Water production was monitored continuously by utilizing a Parshall flume and still well adapted with a Stevens Type F recorder. These are mounted as the outlet for the blooey pit at each site. As production (by virtue of the air-mist injection during drilling) increases and decreases, the water level fluctuations in the still well raise and lower a float device attached to the recording drum and pen. Converting the recordings (in tenths of a foot) to gallons per minute thus enables one to plot and evaluate the production versus depth for the well. Figure 1 attached shows water prodution and temperature versus depth.

Water production on CH-12 remained negligible until a depth of 630± feet was reached, at which time the well produced 20± gallons per minute (gpm). Production increased to 60 gpm at 780 feet and gradually increased to 70 gpm at 1120 feet, a maximum for the upper aquifer. Production then increased to 150 gpm at 1360 feet. The lower aquifer began producing water at this point, with a rapid increase to 270± gpm at 1460 feet. Maximum production for the combined aquifers was 295 gpm, reached at 1640 feet. Production remained relatively stable to total depth.

WATER QUALITY

Water quality was monitored throughout the drilling. At approximately thirty-foot intervals, a sample was tested for temperature, pH, and conductivity. In addition, samples were collected at 200-foot intervals. Samples were also collected at four intervals: 1) at first significant production, 2) during "B groove" pump test, 3) significant increase below "B groove" and 4) at total depth. Table 1 below summarizes the thirty-foot water quality measurements.

Temperature and pH. Figure 1 shows the temperature variations of the water produced during drilling. These ranged from a low of 50°F to a high of 76°F.

Upper aquifer temperatures ranged from 50° to 65°F to a depth of 1280 feet. Combined aquifer water averaged 70°F below 1280 feet, with a distinct increase at the top of the lower aquifer (1280± feet).

The pH records show a high reading of 8.5 and a low of 7.0. The pH record is shown on Figure 2 attached.

Conductivity. Corrected conductivity readings, (see Figure 2) give values ranging from a low of 1476 umhos/cm to a high of 3800 umhos/cm. The upper aquifer averaged approximately 1700 umhos/cm to 890 feet. The combined aquifer average approximately 2860 umhos/cm from 1280 feet to total depth.

TABLE 1

WATER QUALITY CH-12

	Upper Aquifer (540'- 890')	Lower Aquifer (1280' - 1800')
Conductivity (umhos/cm at 25°C)		
High	2020	3800
Average	1700	2860
Low	1476	1820
Temperature (°F)		
High	65	76
Average	59	70
Low	50	61
pH		
High	7.2	8.5
Average	7.0	7.7
Low	7.0	7.2

The Industrial Laboratories Company analyzed the water samples which were collected, and have submitted detailed qualitative results. Copies are not included herein, but are available if a review is necessary.

INFORMAL PUMP TESTS

Two informal pump tests were conducted during drilling. The first was run after penetration of the "B groove" at a depth of 994 feet. The second was conducted at total depth. Each pump test consisted of two hours of continuous airlift pumpage, after which a downhole pressure recorder was lowered inside the drillstring. This instrument records the rising water level as pressure, which can then be converted to feet of recovery. Figures 3 and 4 are the results of these two recovery tests. From these, the calculations of the approximate transmissivity, static water level, and specific capacity can be made for the upper and combined aquifers.

Table 2 below summarizes the results of the pressure bomb tests:

TABLE 2
INFORMAL PUMP TESTS
CH-12

	Upper Aquifer	Combined Aquifer
Production	60± gpm	275± gpm
Static Water Level	450± feet	580± feet
Transmissivity	110 - 7900 gpd/ft	680 - 7300 gpd/ft
Specific Capacity	0.34 gpm/ft of drawdown	1.5 gpm/ft of drawdown

The first recovery test provides approximate values for the aquifer characteristics. The initial rapid increase of the water level to near static water level is somewhat influenced by a "pressuring up" of the aquifer, therefore creating an abnormally high recovery rate. It is rather anomalous in that the sharp break in slope indicates that a boundary effect is present in the vicinity of the well, adding to the rapid recovery. The second calculation of transmissivity (T_2 = 7900 gpd/ft) is an indication of upper aquifer potential. The specific capacity (S.C. = 0.34 gpm/ft) indicates that T_2 is anomalously high, and an average value between T_1 and T_2 is more realistic.

The second recovery test provides realistic estimates for all three aquifer characteristics. The transmissivity of T_2 = 7300 gpd/ft. correlates well with water production in the upper aquifer. The specific capacity (S.C. = 1.5 gpm/ft) also correlates with production and is a realistic estimate.

PRODUCTION LOGGING

Birdwell Well Service Company ran two specialized logs for purposes of evaluating water movement and water temperature in the bore hole. The Temperature Log data are plotted on Figure 5. The Spinner Production Log, which measures the velocity of nonpumping water in the bore hole has not been completely evaluated at this time. It does, however, show that the water movement in the bore hole is downward, thus recharging from the upper to lower aquifer.

Preliminary interpretation of the Production Log indicates major zones of water entry occur in the upper aquifer between 590 and 890 feet. The lower aquifer lies between 1290 and 1800 feet, the interval in which water loss is taking place.

The static water level for the upper aquifer is approximately 450^{+}_{-} feet. The static water level for the combined aquifers is approximately 580^{+}_{-} feet. The differential in head (pressure) between the two aquifers results in the net downhole recharge into the lower aquifer.

SUMMARY AND CONCLUSIONS

Core Hole 12 was completed on September 15, 1974. Preliminary analysis of the data obtained during drilling and informal pump tests yields the following list of conclusions which apprear to be valid for the hydrology of CH-12:

1. Static Water Levels
   - Upper Aquifer: 450^{+}_{-} feet
   - Combined Aquifer: 580^{+}_{-} feet

2. Maximum Production
   - Upper Aquifer: 100 gpm
   - Combined Aquifer: 300 gpm

3. Transmissivity
   - Upper Aquifer: 110 - 7900 gpd/ft
   - Combined Aquifer: 680 - 7300 gpd/ft

4. Sepcific Capacity
   - Upper Aquifer: 0.34 gpm/ft
   - Combined Aquifer: 1.5 gpm/ft

5. Water Quality

Upper Aquifer	- Specific Conductance	2020 micromhos
	- Temperature	50 - 60°F
	- pH	7.0 - 7.2
Combined Aquifer	- Specific Conductance	3800 micromhos
	- Temperature	61 - 76°F
	- pH	7.2 - 8.5

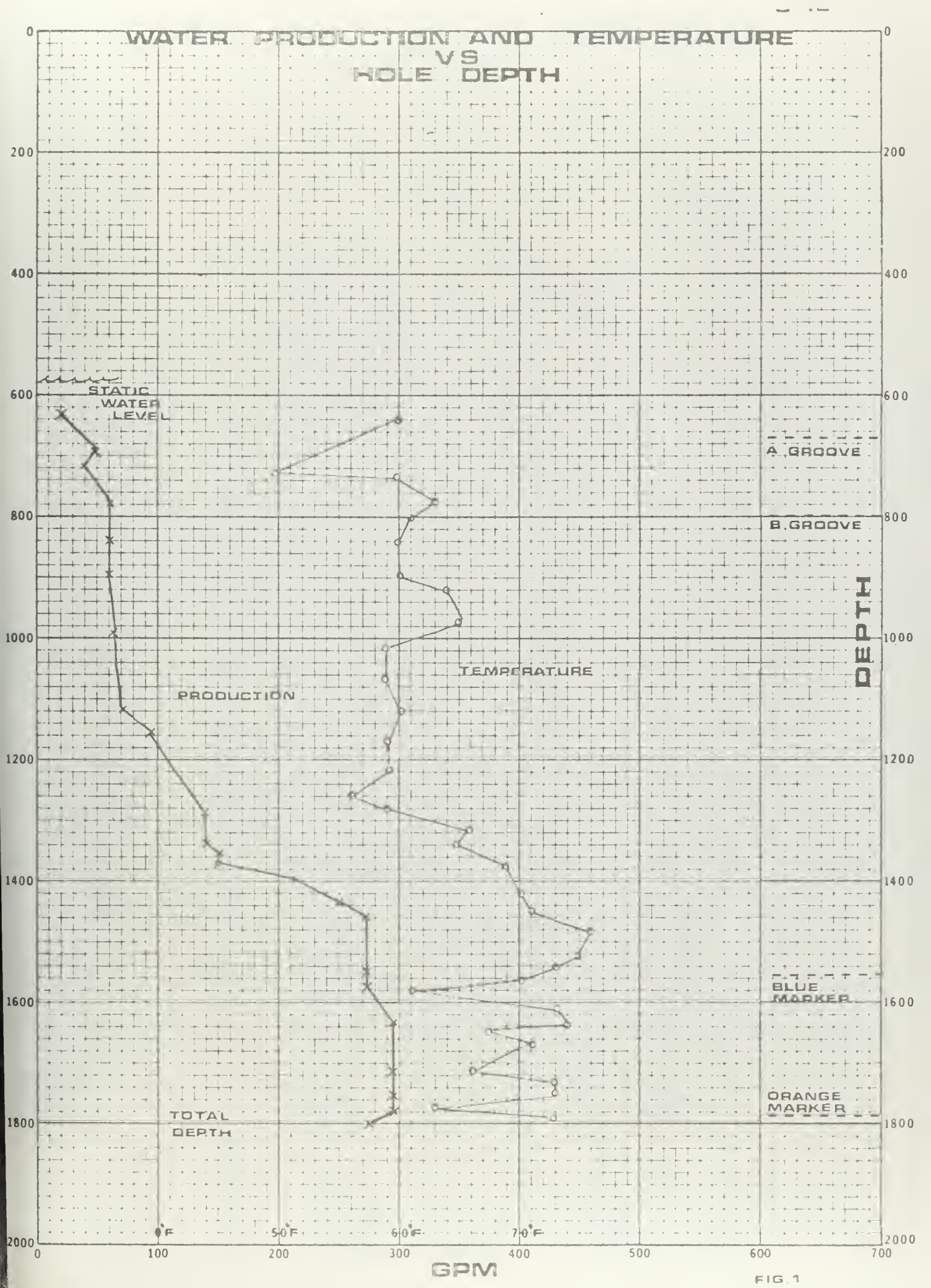

WATER PRODUCTION AND TEMPERATURE
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
PRODUCTION
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
50°F
60°F
70°F
100
200
300
400
500
600
700
GPM

FIG. 1

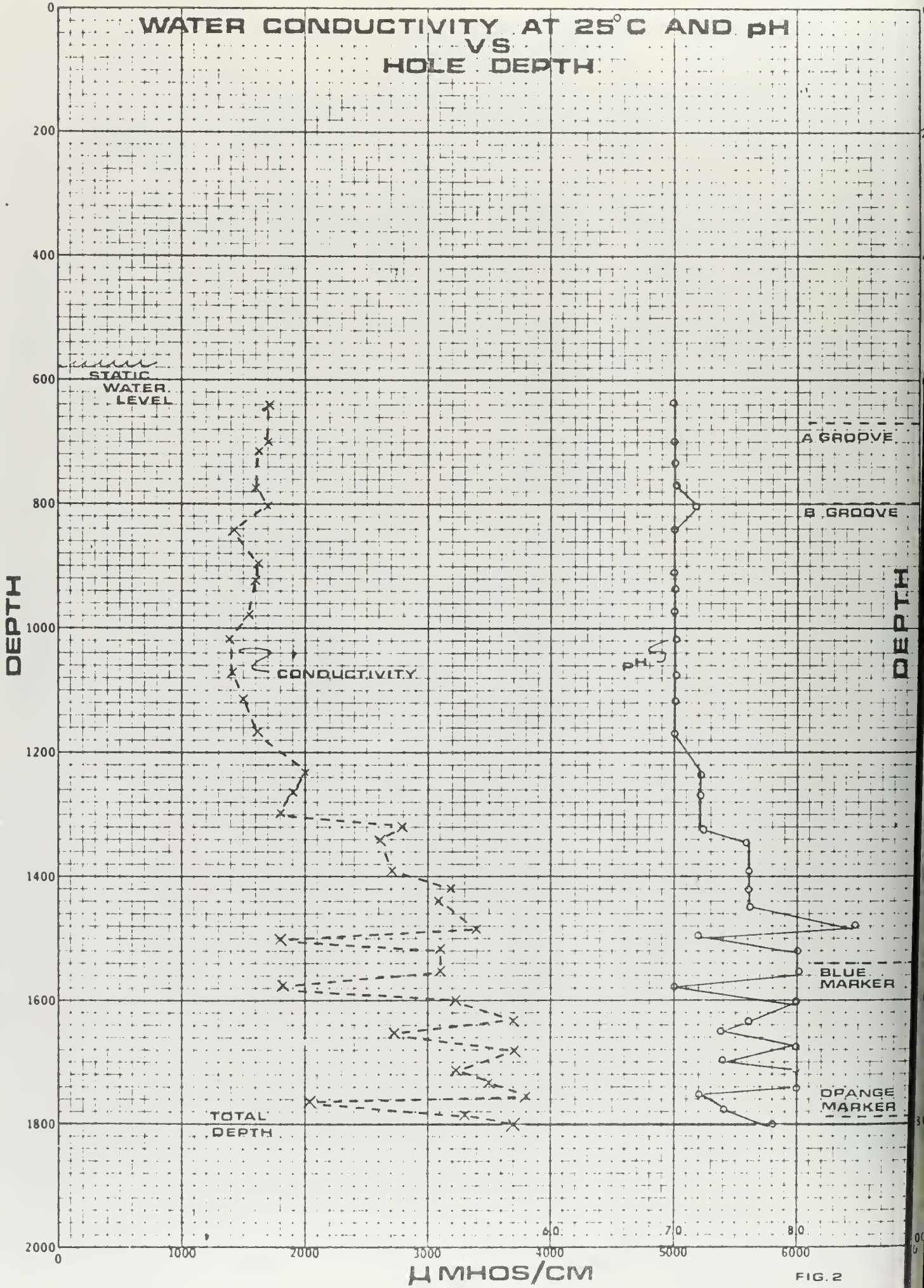

WATER CONDUCTIVITY AT 25°C AND pH
VS
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
CONDUCTIVITY
pH
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH
DEPTH
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1000
2000
3000
4000
5000
6000
6.0
7.0
8.0
μ MHOS/CM
K•E 10 X 10 TO THE INCH 46 0703
KEUFFEL & ESSER CO

FIG. 2

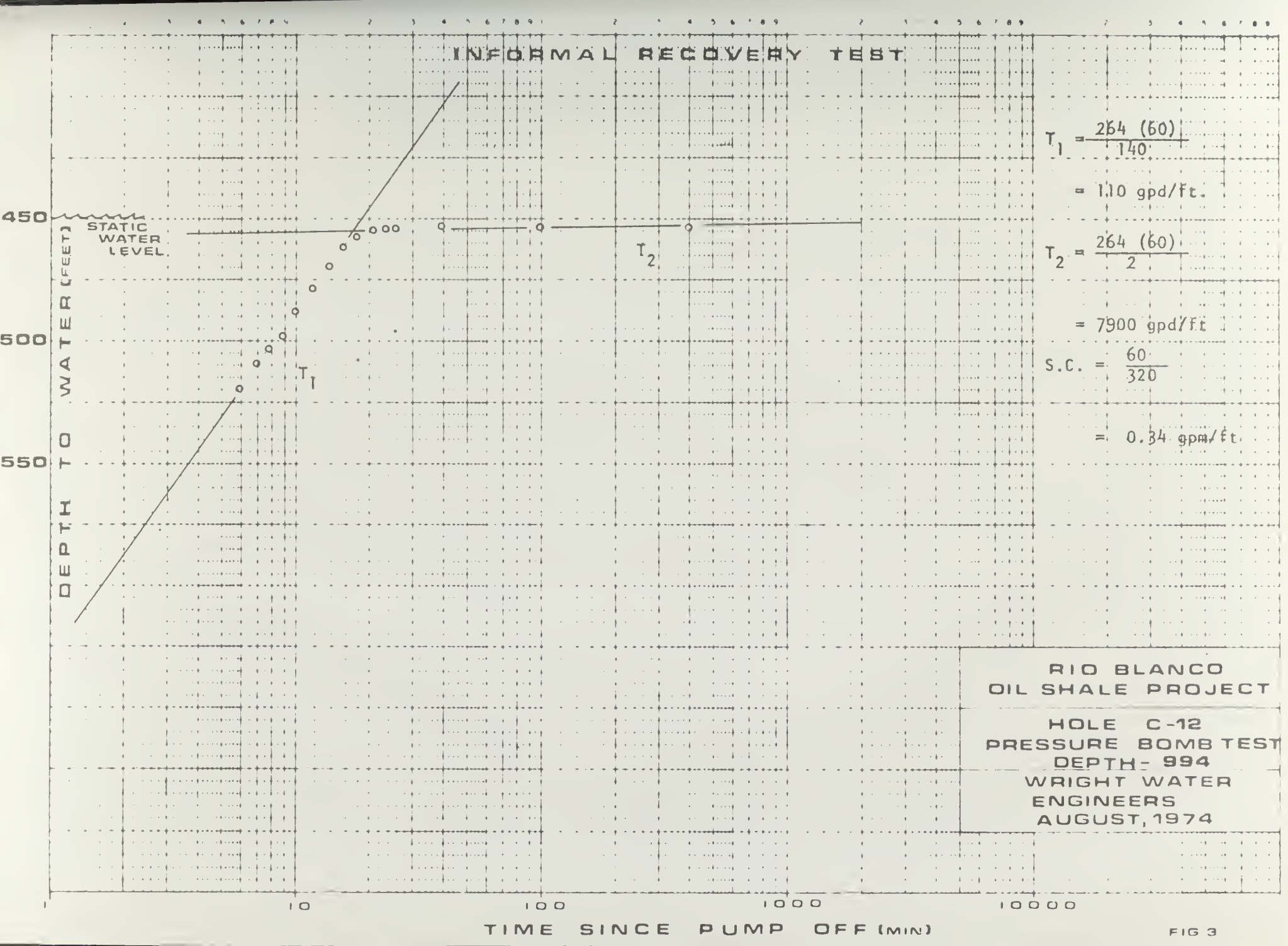
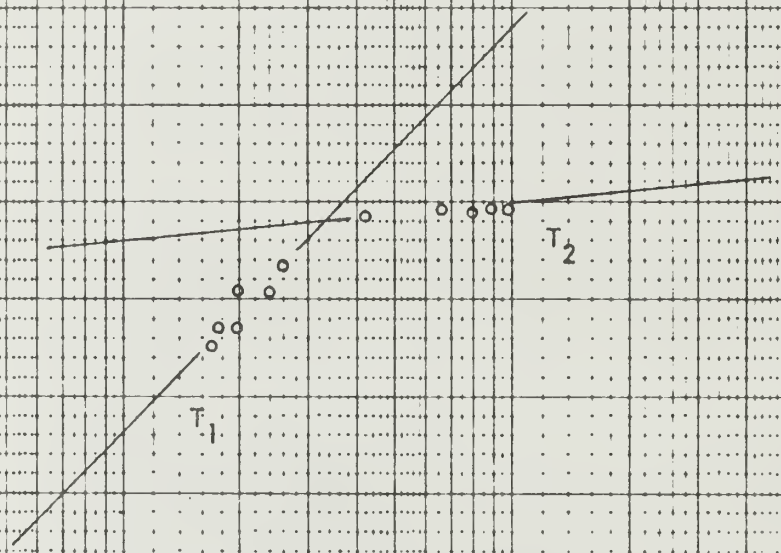

INFORMAL RECOVERY TEST
450
500
550
DEPTH TO WATER (FEET)
STATIC WATER LEVEL
T_1
T_2
$T_1 = \frac{264\ (60)}{140}$
= 1.10 gpd/ft.
$T_2 = \frac{264\ (60)}{2}$
= 7900 gpd/ft
S.C. = $\frac{60}{320}$
= 0.34 gpm/ft
RIO BLANCO
OIL SHALE PROJECT
HOLE C-12
PRESSURE BOMB TEST
DEPTH - 994
WRIGHT WATER
ENGINEERS
AUGUST, 1974
1
10
100
1000
10000
TIME SINCE PUMP OFF (MIN)

FIG 3

INFORMAL RECOVERY TEST



DEPTH TO WATER (FEET)

0

0

$T_1 = \frac{264\ (275)}{105}$

$= 680$ gpd/ft

$T_2 = \frac{264\ (275)}{10}$

$= 7300$ gpd/ft

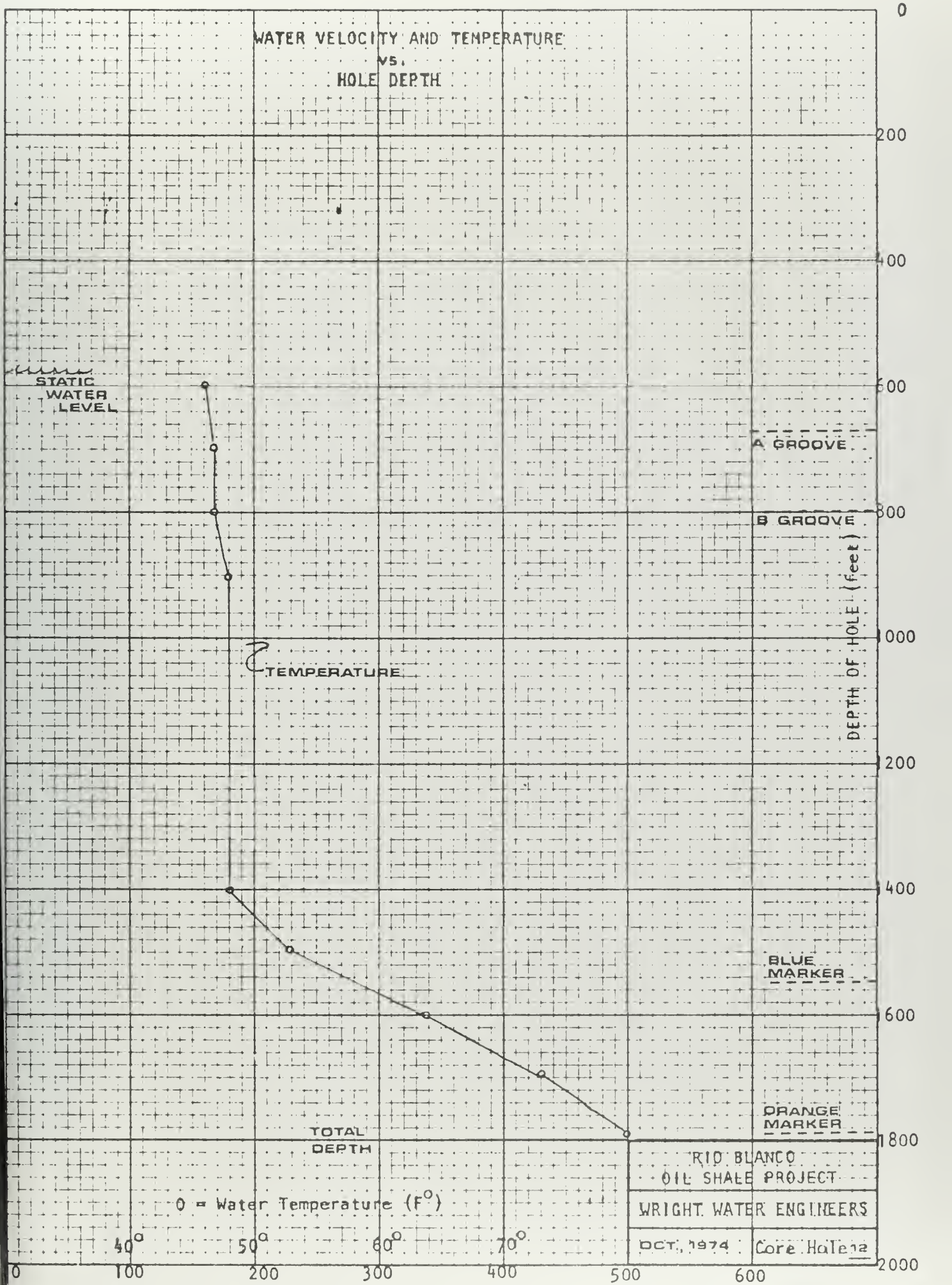
$S.C. = \frac{275}{180}$

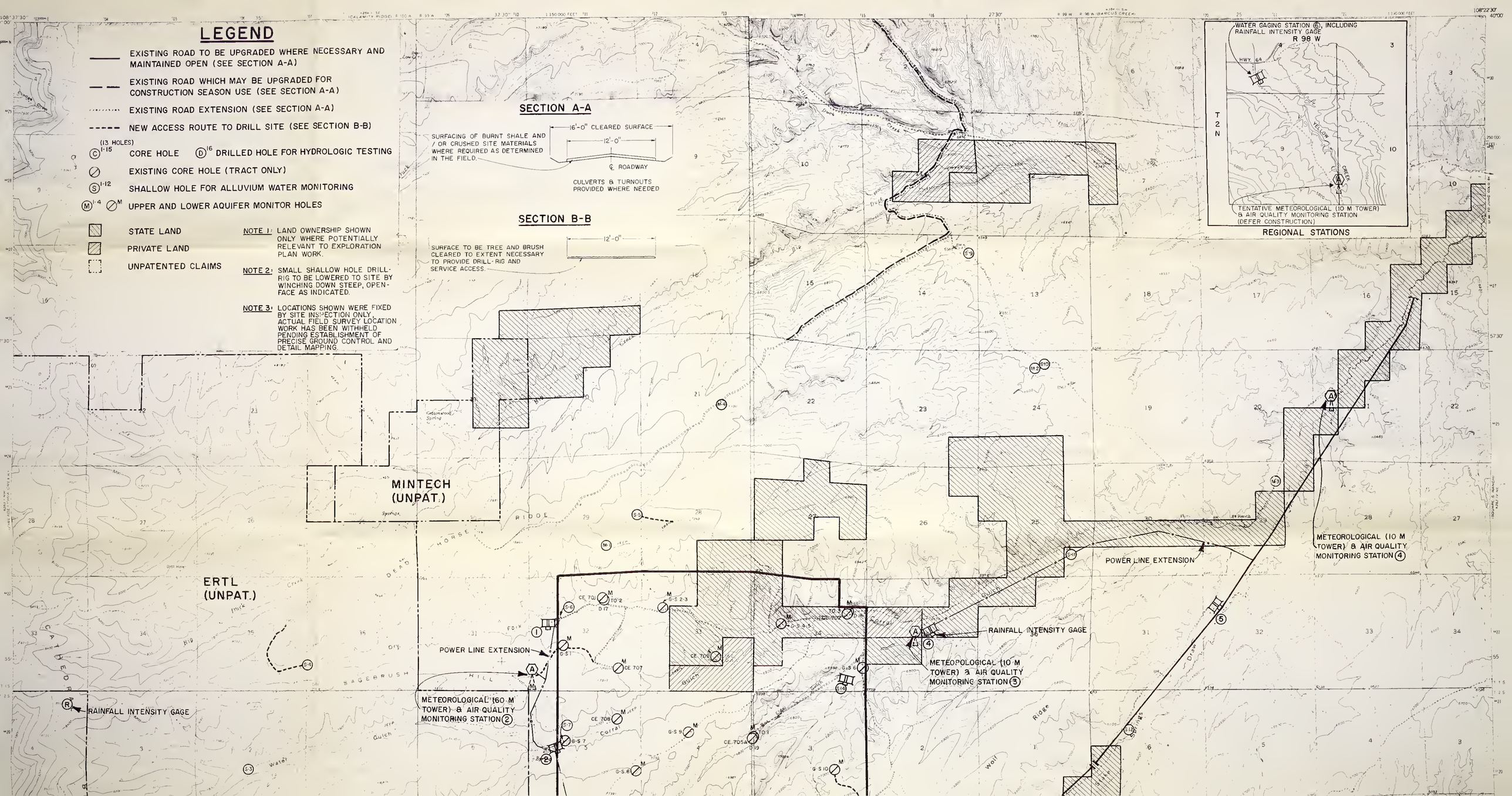
$= 1.5$ gpm/ft

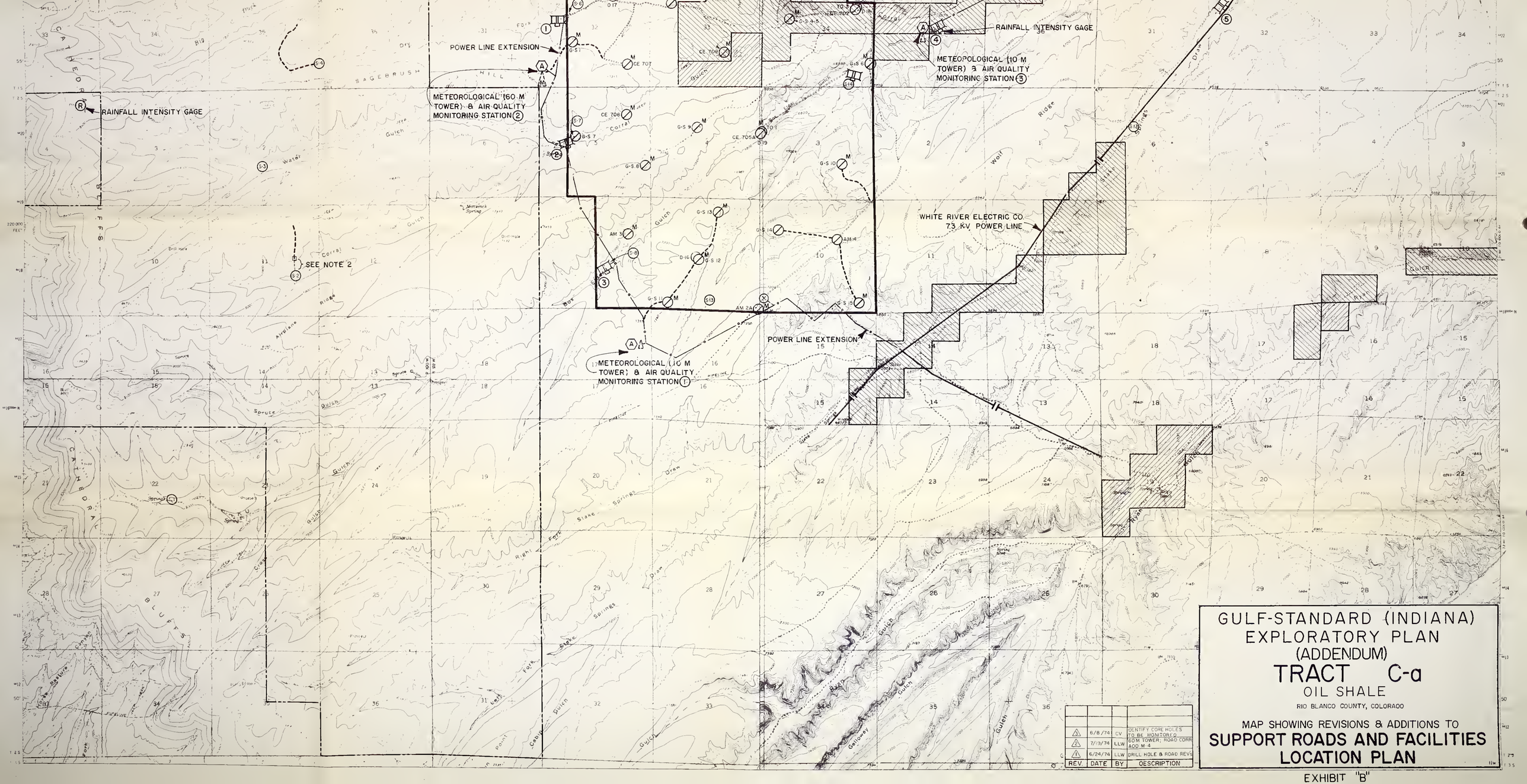
RIO BLANCO
OIL SHALE PROJECT

HOLE C-12
PRESSURE BOMB TEST
DEPTH-1800

WRIGHT WATER
ENGINEERS
AUGUST, 1974


WATER VELOCITY AND TEMPERATURE
vs.
HOLE DEPTH
STATIC WATER LEVEL
A GROOVE
B GROOVE
TEMPERATURE
BLUE MARKER
ORANGE MARKER
TOTAL DEPTH
DEPTH OF HOLE (feet)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0 = Water Temperature (F°)
40°
50°
60°
70°
0
100
200
300
400
500
600
RIO BLANCO
OIL SHALE PROJECT
WRIGHT WATER ENGINEERS
OCT., 1974
Core Hole 2


LEGEND
EXISTING ROAD TO BE UPGRADED WHERE NECESSARY AND MAINTAINED OPEN (SEE SECTION A-A)
EXISTING ROAD WHICH MAY BE UPGRADED FOR CONSTRUCTION SEASON USE (SEE SECTION A-A)
EXISTING ROAD EXTENSION (SEE SECTION A-A)
NEW ACCESS ROUTE TO DRILL SITE (SEE SECTION B-B)
(13 HOLES) C 1-15 CORE HOLE
D 16 DRILLED HOLE FOR HYDROLOGIC TESTING
EXISTING CORE HOLE (TRACT ONLY)
S 1-12 SHALLOW HOLE FOR ALLUVIUM WATER MONITORING
M 1-4 M UPPER AND LOWER AQUIFER MONITOR HOLES
STATE LAND
PRIVATE LAND
UNPATENTED CLAIMS
NOTE 1: LAND OWNERSHIP SHOWN ONLY WHERE POTENTIALLY RELEVANT TO EXPLORATION PLAN WORK.
NOTE 2: SMALL SHALLOW HOLE DRILL-RIG TO BE LOWERED TO SITE BY WINCHING DOWN STEEP, OPEN-FACE AS INDICATED.
NOTE 3: LOCATIONS SHOWN WERE FIXED BY SITE INSPECTION ONLY. ACTUAL FIELD SURVEY LOCATION WORK HAS BEEN WITHHELD PENDING ESTABLISHMENT OF PRECISE GROUND CONTROL AND DETAIL MAPPING.
SECTION A-A
SURFACING OF BURNT SHALE AND / OR CRUSHED SITE MATERIALS WHERE REQUIRED AS DETERMINED IN THE FIELD.
16'-0" CLEARED SURFACE
12'-0"
℄ ROADWAY
CULVERTS & TURNOUTS PROVIDED WHERE NEEDED
SECTION B-B
SURFACE TO BE TREE AND BRUSH CLEARED TO EXTENT NECESSARY TO PROVIDE DRILL-RIG AND SERVICE ACCESS.
12'-0"
WATER GAGING STATION (C), INCLUDING RAINFALL INTENSITY GAGE
R 98 W
HWY. 64
T 2 N
YELLOW CREEK
TENTATIVE METEOROLOGICAL (10 M TOWER) & AIR QUALITY MONITORING STATION (DEFER CONSTRUCTION)
REGIONAL STATIONS
MINTECH (UNPAT.)
ERTL (UNPAT.)
POWER LINE EXTENSION
RAINFALL INTENSITY GAGE
METEOROLOGICAL (60 M TOWER) & AIR QUALITY MONITORING STATION (2)
METEOROLOGICAL (10 M TOWER) & AIR QUALITY MONITORING STATION (3)
METEOROLOGICAL (10 M TOWER) & AIR QUALITY MONITORING STATION (4)
POWER LINE EXTENSION
RAINFALL INTENSITY GAGE
SAGEBRUSH HILL
HORSE RIDGE
DEAD MAN GULCH
Wolf Ridge
Dry Fork
Big Dry Creek
Corral Gulch
Spring Gulch
Willow Spring
Water



REV.	DATE	BY	DESCRIPTION
3	6/8/74	CV	IDENTIFY CORE HOLES TO BE MONITORED
2	7/19/74	LLW	60 M TOWER; ROAD CORR ADD M-4
1	6/24/74	LLW	DRILL HOLE & ROAD REVS

GULF-STANDARD (INDIANA) EXPLORATORY PLAN (ADDENDUM)

TRACT C-a

OIL SHALE

RIO BLANCO COUNTY, COLORADO

MAP SHOWING REVISIONS & ADDITIONS TO

SUPPORT ROADS AND FACILITIES LOCATION PLAN

EXHIBIT "B"

Form 1279–3
(June 1984)

BORROWER'S C

TN 859 .C64 R56

Progress report
C-a oil shale

DATE LOANED	BORROWER

USDI – BLM